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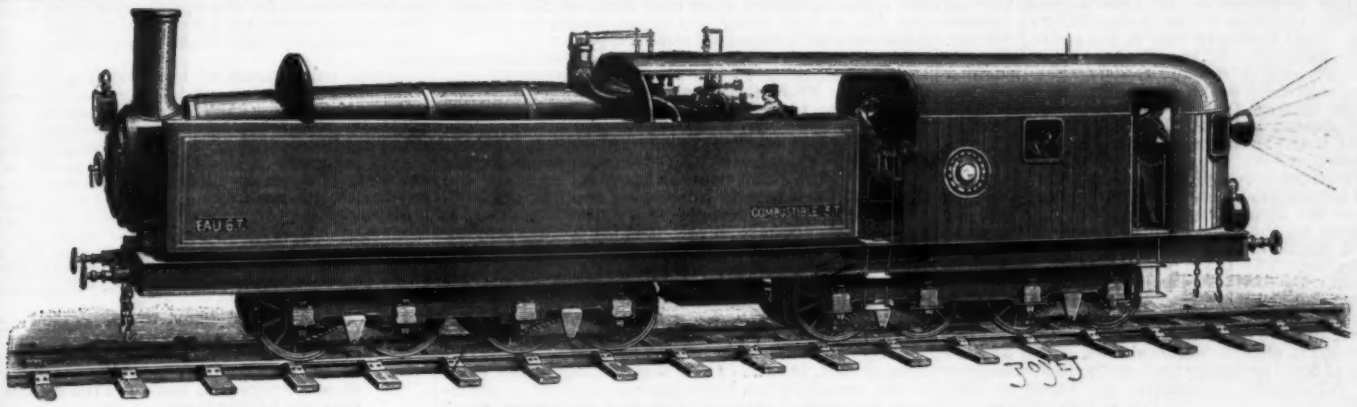
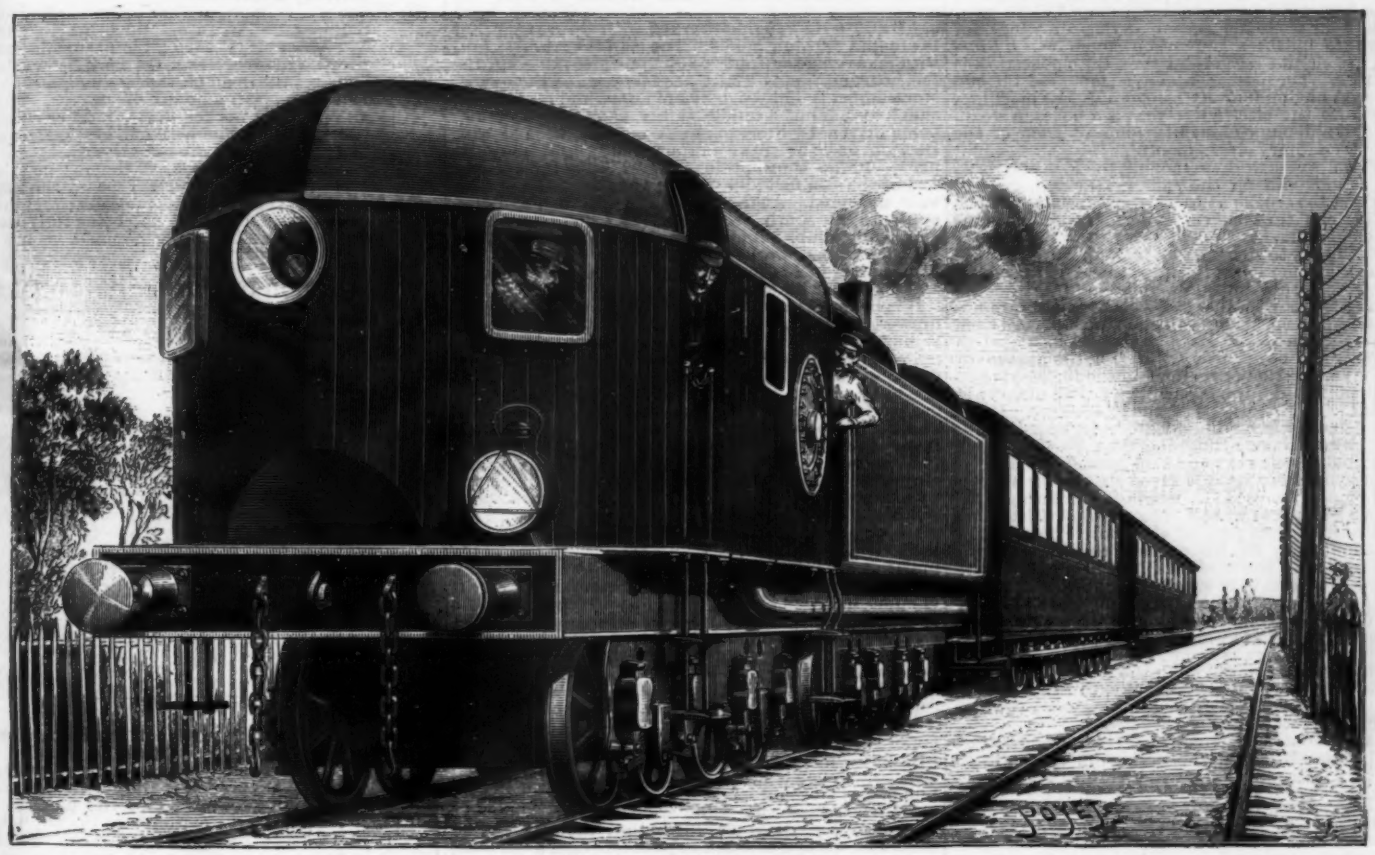
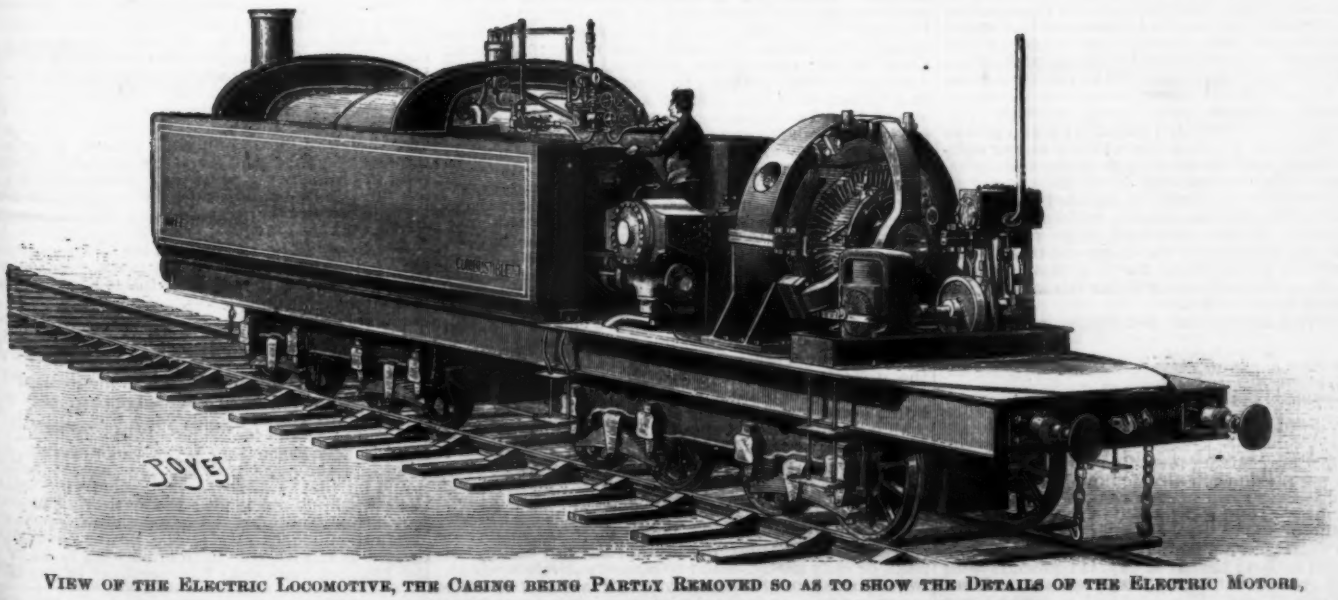


Back of Locomotive. J. J. HEILMANN'S ELECTRIC LOCOMOTIVE. Front of Locomotive.



AN ELECTRIC TRAIN IN MOTION.



VIEW OF THE ELECTRIC LOCOMOTIVE, THE CASING BEING PARTLY REMOVED SO AS TO SHOW THE DETAILS OF THE ELECTRIC MOTORS.

THE AMBULATORY ELECTRIC RAILWAY SYSTEM.

J. J. HEILMANN'S ELECTRIC RAILWAY SYSTEM.

THIS locomotive, which is to be tried on the State railroads of France, is constructed on the following principle: Instead of producing electric energy, that is to say the electric current necessary for traction, by stationary machines placed along the road, and sending it to the mechanism of the locomotive by means of conductors, it is produced on the locomotive itself, which is, in fact, a little ambulatory electric plant.

A steam engine of the Brown type, which is placed on the locomotive, causes the revolution of the exciting dynamo that produces the electric current. From this machine the current is sent to the dynamos on the axles, either of the locomotive only—if the latter is to draw ordinary cars—or of all the cars, if each car is to be an automotor. When the current is sent out all of the receivers or motors on the axles begin to turn, in virtue of the principle of the reversibility of electric machines. This principle was demonstrated by Mr. Hippolyte Fontaine, at the Vienna Exposition, in 1873. Let us recall it briefly: Every electric machine producing electricity by its rotation has two poles like an electric battery; that is, two points at which the produced current gathers. Let us take a second machine that is the same in construction and arrangement as the first. We will connect the poles of the first machine with the corresponding poles of the second by means of copper conductors. The latter begins to turn as soon as the former turns, stops when the former stops, moves at the same rate of speed, in the same time, and with the same reduction of power, caused by friction, etc. This is the principle of the reversibility of electric machines. It cannot be explained, but it is known and utilized. It will be understood that the current produced by a large machine can be utilized in several little machines of the same kind. It can also be stored in electric accumulators, which serve as reservoirs of force or energy that can be used whenever desired. All electric locomotives are based on this principle.

Mr. Heilmann's locomotive has the form of a closed casing or box, with the forward end shaped like a bow, as will be seen from the accompanying drawings, for which we are indebted to our contemporary, *L'Illustration*. It should be noticed that the smokestack is at the rear. The casing, which is mounted on two trucks, each having four axles, contains the machines that produce the electricity; that is a boiler, a steam engine, and a dynamo electric machine. Each of the axles carries a rotary electric motor.

All of the axles work in moving the locomotive, so that it cannot slip on the rails. The casing is so mounted on the trucks as to ride very easily, and the locomotive can turn curves at a great speed without danger of derailment.

People will say to us: "But it is absurd to produce steam on a locomotive only to transform it into electricity. This would be a loss, and then transforming this electricity into motive force would constitute another loss. It seems like mounting on a horse's back after having attached him to a vehicle." This sort of reasoning would be erroneous. In fact, the heat given off by the combustion of the fuel in the furnace is better utilized in the form of electricity than directly in steam acting on the pistons of the locomotive. It can be regulated exactly, and besides, greater speed can be attained, thus economizing the time during which steam locomotives have to be kept heated. Finally, an enormous amount of heat is saved that in steam locomotives would be used in moving connecting rods, cranks, and immense wheels, the jar and friction of which absorb a great part of the motive force. The system adopted by Mr. Heilmann is, therefore, logical. Without altering the roadbeds, he will be able to attain a speed of from 56 to 62 miles per hour.

One of the advantages, and also the principal inconvenience, is the burning of coal and the vaporizing of water on the electric locomotive itself. The inventor, in studying this arrangement, proposed to utilize the enormous amount of material in the cars now on our railroads; but proposed, eventually, to attach to the electric locomotive special cars, the axles of which should carry a receiving electric machine.

The experimental machine shown in the engravings is not perfected, but the experiments tried with it will be very instructive, and will certainly give practical results.

THE CLAMOND MICROPHONE.

For the last twelve years so-called new microphones have been appearing, all of which, however, have involved contacts of unyielding carbon, the resistance of the contacts varying under the influence of the sound waves. This form of microphone, nevertheless, has the inherent defect of permitting only sounds of medium intensity to be transmitted, since if the pressure at the points of contact is slight, the instrument is too sensitive, transmitting feeble sounds, louder ones only causing crackling due to ruptured contacts; while if the pressure is greater, the instrument is no longer sufficiently sensitive, and the speaker is obliged to shout. To overcome this, constructors have endeavored to gain a *juste milieu* by carefully adjusted regulation. The aim of M. Clamond has been to avoid all necessity for adjustment. He has gone back on previous experience, and has abandoned the loose contact of unyielding carbon, substituting for it a plastic elastic body, the *shape* of which alters under the influence of the impinging sound waves.

The Clamond microphone (see figure) is composed

of a paste made by mixing some fine conducting powder with a viscous non-conducting liquid. This paste, C, is placed between two carbon rods, A B, connected with a diaphragm, and is deformed in the manner depicted by the action of the voice. Experiments made are said to show that a microphone of this type has a wide range of action; that is to say, it transmits with equal facility words softly and loudly spoken, strident noises and violent explosions. It is also claimed that the Clamond microphone is outside the Berliner patent, and should, therefore, meet with a warm reception in the United States.—*P. Clémenceau, in L'Electricien; The Electrician.*

GAS POWER FOR ELECTRIC LIGHTING.

AT a recent meeting of the Institution of Civil Engineers, Mr. J. Emerson Dowson read a paper on the above subject, of which the following is an abstract:

The author stated that in Great Britain alone gas engines had been sold for electric lighting purposes exceeding in the aggregate 7,000 horse power, and that in Germany they are now used for about 1,100 arc and 90,000 glow lamps. It was, however, only within the last few years that gas engines of large size had been before the world in a practical form. The varying load factor in central stations was a serious trouble, and the author hoped to show that much of the present loss, due to fuel, water and wages, would be avoided if gas were used instead of steam power.

Special reference was made to the central station at Dessau, belonging to the German Continental Gas Company. This station was opened in 1886 with two 60, one 30, and one 8 horse power (effective) engines, worked by town gas; and all the dynamos were driven by belting and countershafts. In 1891 considerable alterations were made. One 60 horse power engine, with its belting and countershaft, was retained and one of 120 horse power introduced, coupled direct to its dynamo. The speed of the engine and coupled dynamo was about 145 revolutions per minute, and the consumption of gas was equal to 29 cubic feet per kilowatt. Formerly, without accumulators, it was thought necessary to adjust the size of the engines to the service, so that they should always be worked to their full extent. It had, however, been found that a limited supply could be more advantageously furnished entirely from accumulators. The author stated his opinion that, in spite of the loss of about 21 per cent. in the accumulators, large engines work more profitably in parallel than smaller ones supplying direct without accumulators. Since February, 1889, the municipality of Schwabing, a suburb of Munich, have used an "Otto" engine, worked with Dowson gas, for 10 arc and 300 glow lamps. The load is variable; but, with an average output of 22·5 kilowatts per hour, the fuel consumption is 3·3 lb. per kilowatt. The town of Morecambe is lighted by 9 arc lamps and glow lamps equal to 1,600 of 8 candle power each, the dynamos being driven by Stockport gas engines, worked with Dowson gas. With an output of only 1,155 kilowatts per week, the consumption of fuel is 2·58 lb., and the cost of the gas, including wages and fuel, ¼d. per kilowatt delivered. At the chateau of Mr. Say, at Longpont, in the south of France, there 650 glow lamps and 1 arc lamp, supplied by a dynamo driven by a Crossley engine, worked with Dowson gas. The consumption of fuel is 1·2 lb. per indicated horse power, and 2·7 lb. per kilowatt per hour.

It is believed that the late Sir William Siemens first drew attention to the fact that, when illuminating gas is burned in a gas engine to drive a dynamo, much more light is produced electrically than can be produced by consuming the same quantity of gas in burners in the usual way. Latterly the consumption of gas per horse power in gas engines has been reduced; and the ratio is at the present time about 20 to 1 in favor of converting the gas into an arc light by means of a gas engine. The author has collected data from various sources as to the consumption of ordinary gas by engines supplying electric light with and without accumulators. The average of all the returns, with engines under varying loads and without accumulators, is about 47 cubic feet per kilowatt hour. When accumulators are used, the consumption of gas is less, because the engines then work under a full load. With 47 cubic feet per kilowatt, and 55 watts per 16 candle power, one light of this power requires only 2·6 cubic feet per hour; whereas a standard Argand burner requires 5 cubic feet per hour. In making this comparison, it was assumed that the glow lamps and gas burners were in good order; but, under ordinary working conditions, they did not maintain so high a duty.

Mr. Dowson pointed out that the question of load factor is a serious one with any type of engine: but with gas engines the loss is much less than with steam engines. When a gas engine is stopped, its consumption of fuel stops also, and there is no furnace to maintain; nor is there any water to boil at starting. At the same time it is desirable that the gas engine should be worked as much as possible under a full load; and in this respect the experience at Dessau has been generally confirmed. A central station was worked under trying conditions; and in the London district there was only a full output of current during from three to five hours in every twenty-four; moreover, about 60 per cent. of the total output was required during this short period. In practice this meant that, in a station where the current is supplied without accumulators, the engines were run at a reduced speed during a portion of the time, and at other times some of them were stopped altogether; but all had to be ready to work in the evening, and occasionally in the daytime, when there was fog. The author thought that, generally, it might be assumed that the average consumption is more than 6 lb. per kilowatt where accumulators are employed, and about 9 to 12 lb. where they are not used. In any case, with the best possible arrangement of steam power, there must be a large amount of fuel consumed which does no useful work; for, even if some of the fires are drawn, they have to be relighted, and the large quantity of water which has cooled during the time of standing must be reheated.

The author expressed his belief that the solution of the difficulty is to be found in the use of gas plant instead of steam plant. With a large gas engine, one brake horse power per hour could, he said, be obtained with a consumption of about 1 lb. of anthracite, or 1½ lb. of coke; whereas the consumption of coal with the steam engines used for central stations must be taken at about 2¼ lb. per brake horse power, when working under a full load. A saving of not less than 50 per cent. could, therefore, be effected in stations where the engines are fully loaded; and, where there are great fluctuations in the output, the loss of fuel with boilers not used, or only partly, could be almost entirely avoided. For a maximum of 400 kilowatts, there would be three gas generators, each capable of supplying one-third of the maximum required. The production of gas could be raised or lowered in several ways; and the working of each generator could be stopped immediately by shutting off its supply of steam. Supposing, therefore, that all three generators were working at their maximum rate, and a gradual reduction was required, this could easily be effected; and when the production of one or two generators could be dispensed with, their operation was at once stopped. The third generator could then be kept at work, and its production adjusted to suit the minimum consumption required. A gas generator has a small grate area compared with that of a boiler, and much less cooling surface; it does not contain any water, and requires no chimney draught. A generator of the size referred to would lose only from 6 to 8 lb. per hour while standing. If an average of only 40 per cent. of the maximum power were required for 21 hours, it was equivalent to letting two of the generators stand for this period; and, at 8 lb. each per hour, this meant a total loss of only 3 cwt. compared with the much greater waste when steam power was used.

As the employment of large engines, driven with generator gas, is of recent date, the author proceeded to describe the gas plant used. He gave the results of engines working regularly with Dowson gas, under the usual conditions obtaining in factories, as well as others of brake tests made with several engines of large size; and he reproduced indicator diagrams taken from engines of different makers. Though some admirable results had, he said, undoubtedly been obtained from engines working with the "Otto" cycle, he was of opinion that, with engines of large size, the results would be still better if the cycle were altered, especially when generator gas was used. His reasons for this were fully stated in the paper.

The following is a summary of the points urged by the author:

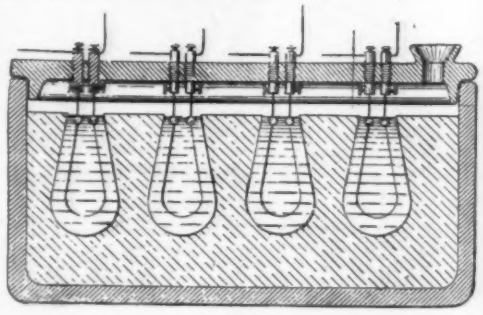
(1) When ordinary gas is used for driving the engines of an electrical station, the consumption is about 50 per cent. less than the volume of gas required to give the same amount of light by ordinary burners.

(2) When gas is used, neither boiler nor firemen are required, and there are no ashes to remove; less space is needed; no accumulators are necessary, except such as may be wanted to equalize the load of the engines, and to provide for a small amount of storage. The engines can be worked in the most crowded districts, close to where the lights are required, and where boilers are not allowed.

(3) When generator gas is used, the consumption of fuel under a full load will be at least 50 per cent. less than with steam power; and the loss due to steam boilers not being fully worked can be almost entirely avoided.

A NEW METHOD OF PREPARING FILAMENTS FOR INCANDESCENT LAMPS.*

THE method of making filaments described in the following article is used by the Actien Gesellschaft für Elektrische Glühlampen in Budapest.



The filament is constructed in three layers, of which the core is the actual carbon thread. It is soaked with a mineral gum, and is covered with a non-conducting sheath of silicate which melts during the carbonization and serves not only to protect the filament from burning during the process and from the air, but also to give it a smooth surface on which the third layer (which is necessary to adjust the resistance) can be finely and evenly deposited.

Hitherto the resistance of the filament has been adjusted after fixing in the bulb; but in the present case the thread is completed before being placed in position. It is usual to adjust the resistance by heating in a liquid or gas from which carbon can be deposited; but the currents set up by the heating hinder the process, owing to the contained oxygen acting on the depositing carbon, and spoiling its quality. The filaments are, therefore, heated in this process in a bath of paraffin or naphthalin, or some similar hydrocarbon, solid at ordinary temperatures. Since only the particles in the immediate neighborhood of the filament become liquid, no appreciable convection currents are set up.

The construction of the bath may be seen from the annexed figure. The complete process is as follows: The woolen, silk or cotton thread is steeped in a solution of—

Water glass	25% to 30%
Senegal gum	10% to 15%
Caustic soda	12% to 13%

It is then rolled, being bent into the form of an angle iron, this form having the advantage of possessing many sharp edges, which, says the *Zeitschrift*, are known to be more luminous than surfaces. The filament is then carbonized in the usual manner, and replaced in the paraffin bath, the paraffin solidifying round it; the necessary arrangements for measuring their resistance are made; the current is passed, and particles of carbon are deposited on the silicate sheath. When the filament attains the proper resistance, the current is cut off, the bath of paraffin is melted, and the filament removed; the particles of paraffin are

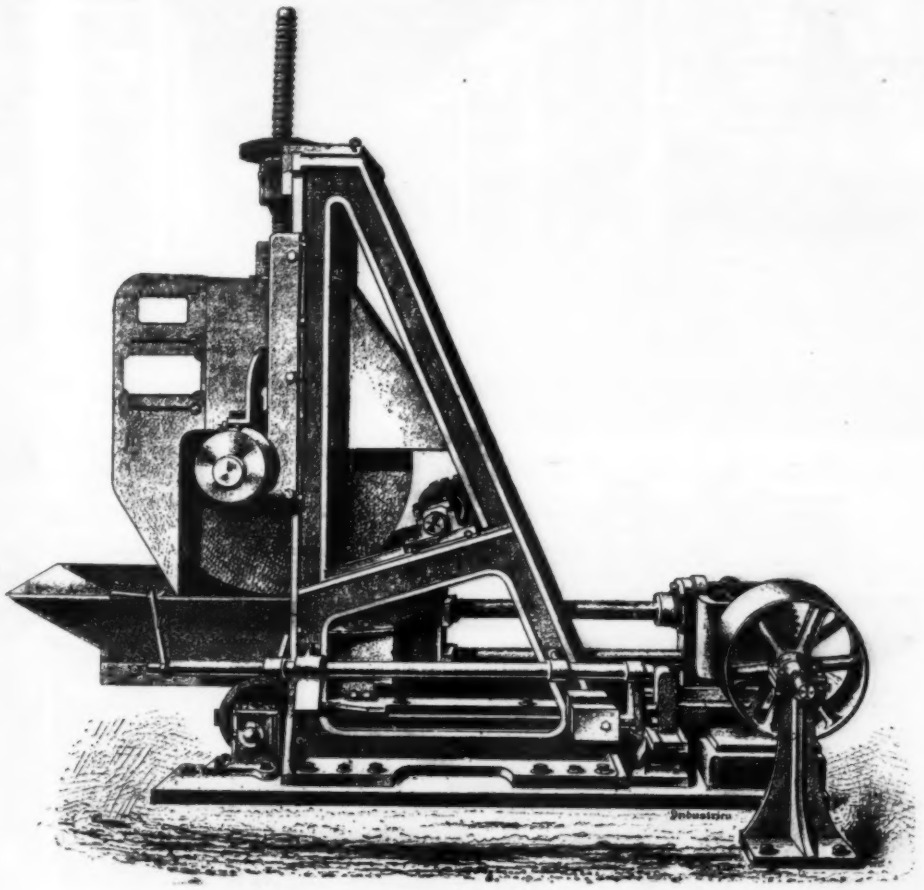
* Abstract from *Zeitschrift fur Electrotechnik*, November 1, 1892.

cleared off by alcohol, and the filament is then ready to be fixed in the lamp.

The method is said to possess the following advantages: The gum gives the filament great toughness and strength. The silicate sheath again strengthens it and forms an evenly constructed whole. The adjustment of the resistance is much easier, as paraffin is the most suitable hydrocarbon for the purpose of depositing carbon, while the solid bath prevents all access of air during the process.—*The Electrician.*

IMPROVED FILE GRINDING MACHINE.

THE illustration represents a general view of an improved machine for grinding files, etc., made by Messrs. Oxley Brothers, engineers and iron founders, Sheffield—a firm having a very large experience of the construction of tools of this description. In Sheffield great attention is being devoted at the present time to milling and grinding edge tools; in many instances articles that were formerly planed at considerable expense are now surfaced by special tools of the class shown. The machine is made in two sizes, the largest taking a grindstone 6 ft. diameter and 12 in. wide, and will grind surfaces perfectly flat, convex, concave or copy almost any shape of outline from 6 in. to 30 in. long. For file grinding the machine shown is stated to be specially adapted, and is capable of finishing 30 dozen 18 in. files and 400 dozen 6 in. taper saw files in a working day of ten hours. The articles to be operated upon are placed in the shallow trough shown, which has a reciprocating motion in proportion to the curvature required. The trough is partially filled with water to prevent any hardening or glazing of the articles being treated. A number of these machines are



IMPROVED FILE GRINDING MACHINE.

now in use, and are giving, we are informed, entire satisfaction.—*Industries.*

MOTORS FOR AERIAL MACHINES.*

MY own estimate of the power required by a common pigeon gliding at an angle of 1° with the horizon was 9·33 H. P. per ton of his weight, and 10·49 H. P. per ton at an angle of 2° for this same velocity of 25 miles per hour.

These are considerably less than the powers required to drive a balloon of moderate size at the same speed, for we have already seen that the air ship La France would require 51 H. P. to attain 25 miles per hour; or, as it weighs 2·2 tons, the motor would need to develop 23·2 H. P. per ton of the weight of the whole apparatus. For the balloon of double this size, the power required is at the rate of 10·34 H. P. per ton of apparatus. This power required would, moreover, increase in the case of the balloon as the cube of the velocity, while M. Drzewieki shows that in the case of an aeroplane the power will increase only in the direct ratio of the speed, because as the velocity becomes greater the area sustaining surfaces required becomes less, and he estimates that an aeroplane will require 10·43 H. P. per ton to go 44·72 miles per hour, and 20·62 H. P. per ton of its weight at 89·44 miles per hour.

This brings up the question of possible motors, and if we confine ourselves for the present to 25 miles per hour, and assume the power required at 10 H. P. per ton of apparatus, we see at once that only a fraction of that weight can be devoted to the motor. Let us assume, and I think this is not far wrong, that only one-quarter of the weight can be apportioned to the motor and its supplies, the remaining three-quarters being required for the weight of the framing, the aeroplane surfaces, the various appurtenances and the aeronauts, we then have but $\frac{2000}{4 \times 10} = 50$ lb. per H. P. as the weight allowable for the motor and its supplies for such period of time as it is to consume in its trip. This does not greatly differ from the proportion in the pigeon, whose pectoral muscles weigh $\frac{1}{11}$ of his total weight, or 46 lb. per H. P., including, it must be remembered, the stored-up energy which enables him to accomplish long flights without alighting.

Now, how does this compare with the weight of the engines manufactured by man? There are three classes of motors in general use.

1. Steam engines.
2. Gas engines.
3. Electric motors.

The machines in common use, being designed chiefly for strength and durability, are needlessly heavy, and it is only by inquiring into what has been done for special purposes that we shall get an idea of their possibilities.

Thus as to steam engines: Ordinary stationary machines weigh with their boilers from 500 to 1,600 lb. per H. P.; locomotives from 200 to 300 lb.; marine engines for Atlantic steamers 480 lb., and light launch engines —those of Herreshoff, for instance—some 60 lb. per H. P. For aeronautical purposes, however, a steam engine was built by Stringfellow which weighed but 13 lb. and exerted 1 H. P., and another was built by Moy and Schill of 3 H. P. and 80 lb. weight, thus being about 27 lb. per H. P.

But these weights, while including the boiler, do not include the water and fuel. These supplies may be estimated at 22 lb. of water and 4 lb. of coal per hour, so that if a large engine can be built as light per H. P. (13 lb.) as that of Stringfellow, it would still need, if for so short a trip as two hours, 52 lb. of supplies per H. P., making a total of 65 lb., including the engine itself.

The principal weight is that of the water. It has been proposed to utilize part of this over and over again, by equipping navigable balloons with surface air condensers, but the difficulties in the way of this, chiefly from the added weight, are almost insuperable.

Next, therefore, gas and petroleum engines suggest themselves. As now made they are excessively heavy, weighing from 280 to 1,000 lb. or even more per H. P., so that the advantages of dispensing with the boiler and its water supply are completely lost. They are comparatively of recent invention, however, and it is believed that corresponding reductions of their weight can be made,* such as have been effected for the steam engine, and as will be seen hereafter for electric motors, and that this is a promising field for experiment; for even if aerial navigation be a Utopia never to be realized, improvements which will permit a reduction in the weight of gas engines are likely to cheapen their cost materially, and to extend their use, as well as the profits of their builders.

And, lastly, we will consider the electric motors, with which whatever of success the navigable balloon has so far attained has been accomplished. They involve, like the steam engine, two separate parts, the motor proper and the generator, which latter may be either a primary battery or an accumulator.

The weights of the motors or ordinary dynamos used in this country run from 92 to 260 lb. per H. P. developed, while abroad they run from 68 to 350 lb. per H. P.; but the special dynamo used by Commandant Renard weighed but 26·4 lb. per H. P., and a very small one, built of aluminum by M. G. Trouvé, weighed at the extraordinary rate of but 7·7 lb. per H. P.

M. Trouvé is now building for the Portuguese government a 10 H. P. dynamo, which will weigh less than 220 lb., and which is to be used to drive a navigable balloon. The total weight of the motor, batteries for several hours of work, screw and accessories, is estimated at 1,496 lb., or at the rate of 149·6 lb. per H. P. developed.

Contrary to expectation, accumulators are found, by comparison of numerous data from various makers, gathered by M. Tissandier, to be actually heavier than primary batteries. As they are charged to last various periods of time, it is necessary, in order to compare them, to reduce them to the common standard of one H. P. for one hour, and it is then found that accumulators of the best make weigh from 107 to 162 lb. per H. P. per hour, a fair average being 135 lb.; while the primary battery of Commandant Renard is stated by himself to weigh but 66 lb. per H. P. per hour, and to last a little over 10 hours, this being the present possible length of his trips. Thus the motor is decomposed into 26·4 lb. of dynamo and 103·6 lb. of primary battery, making in the aggregate the 130 lb. per H. P., as has already been mentioned.

It will be observed that all these weights of motors are in excess of the 50 lb. per H. P. which have already been assumed as the weight which can be afforded for aerial navigation, and yet not so greatly beyond it as to shut off all hope of improvement. Hitherto it has not been generally realized that the chief obstacle in the way of success is the want of a light motive power, one which shall develop great energy with little weight, and it is possible that when inventors turn their attention in this direction still lighter motors than at present known shall be the result.

It has been suggested repeatedly that a suitable motor for aerial navigation may be found by the invention of some kind of explosive engine, utilizing the force of gunpowder, nitro-glycerine or some other substance which can be flashed from the solid or liquid form to the gaseous condition; but such a motor is yet to be invented, and, what is more difficult, regulated and perfected. Attempts in this direction, notably with gunpowder, actually antedate the steam engine, but the difficulties of controlling power so intense and so rapidly generated have hitherto been found too great to be overcome. It would be rash to say that they cannot be, although true explosive engines have thus far exhibited an unpleasant irregularity of working, frequently giving deficient strokes, but at times coming out with powerful explosions which may kill the inventor.

It is believed that gas or petroleum engines, which are also explosive engines, with the difference that the working substance is already in the gaseous form, and thus subject to fewer irregularities of expansion, present greater chances of success in obtaining a light motor for aerial purposes, and would-be inventors are advised to turn their attention to this rather than in other directions.

But even if the motor is worked out, there will remain some serious difficulties to be encountered before man can fly through the air at satisfactory speeds. The first of these is the requirement for absolute stability which has already been alluded to. The apparatus must balance itself in the air automatically, and must possess sufficient surface to come down as a parachute should the machinery break down while sailing. The second difficulty will consist in the necessity for obtaining high initial velocities, so that the sustaining pressures shall be great, and that the dimensions and weight of the apparatus may consequently be reduced to a minimum. This difficulty of getting under way is the principal one encountered by birds, and probably furnishes the reason why none of them have attained the size of land and marine animals.

It has been pointed out that there are no flying birds much over 30 lb. in weight, and, reasoning from analogy, it has been argued that man cannot hope to improve upon nature in this direction; but not only are birds much more complicated in structure than a flying machine needs to be, having many functions to perform, such as wing-folding, feeding, reproduction, etc., besides that of mere flight, but they evidently expend much more energy in starting than in any other portion of their evolutions.

The smaller ones jump from the ground into the air with all their might, and then beat their wings with much greater rapidity and amplitude than in their normal flight. If rising vertically they soon exhibit signs of distress. The larger birds in starting from the ground are compelled to run considerable distances, always against the wind, in order to gather headway and supporting power, and even with the most energetic flapping they cannot rise at a steeper angle than 45°. All birds prefer to start from a perch, for by directing their first course downward they gather velocity from the action of gravity; at times some of the larger ones obtain relative velocity by simply spreading their wings to the breeze while yet on the perch, the object in every case being to avoid the great exertion required to obtain speed, for once fairly under way they are masters of their movements.

Resort to some equivalent devices will evidently be open to flying machines, but it is evident that until the question of stability has been thoroughly worked out, such experiments will be exceedingly dangerous: no such apparatus has yet succeeded in raising itself from the ground with the whole of its motive power, and the most that can be said at present is that recent elucidations of the laws of flight seem to indicate that it is not impossible for man to succeed with an aeroplane.

There are probably scores of shapes which can be made available for such machines, just as there are hundreds of forms of birds who display various peculiarities in their flight; but in every case there will be the same requirements as to a light motor, absolute automatic stability and some device for gaining initial velocity, as well as for landing safely. This will require much experimenting, and a beginning has scarcely been made, so that even granting the accomplishment

Abstract from a lecture by O. Chanute, delivered at Cornell University, 1890.

* Since reading the lecture, the author has seen an account of a three-cylinder petroleum engine built for marine purposes, in France, which develops 5 H. P., and weighs but 440 lb., thus being in the ratio of 88 lb. per H. P. It consumes, as near as may be, 1 lb. of petroleum per H. P. per hour.

possible, the working out of the problem may prove to be slow.

Success might be much hastened, however, by a working association of searchers in this field of inquiry, for no one man is likely to be simultaneously an inventor, to imagine new shapes and new motors; a mechanical engineer, to design the arrangement of the apparatus; a mathematician, to calculate its strength and stresses; a practical mechanic, to construct the parts; and a syndicate of capitalists, to furnish the needed funds. It is probably because the working out of a complex invention requires so great a variety of talent that progress in other fields has proved so slow, several generations sometimes passing before an important invention, such as that of the steam engine, the telegraph, or the reaping machine, is finally perfected and brought into general use.

CONCLUSION.*

To sum up, therefore, the present "state of the art"—if it has yet progressed sufficiently to be called an art—may be stated as follows:

A measurable success has been attained with navigable balloons. They have been driven 14 miles per hour, and it is possible that speeds of 25 to 30 miles an hour, or enough to go out when the wind blows less than a brisk gale, are even now in sight. Very much more speed than this is not likely to be obtained with balloons, for lack of sufficiently light motive power, and because of unmanageable sizes.

Much greater speeds can perhaps be attained eventually with aeroplanes; recent investigations indicate this; but even a beginning is prevented by the lack of a light motor, and by questions as to the stability of the apparatus, as well as to safe ways of gaining high initial velocities. Whether these difficulties will ever be overcome no one knows, but they indicate the direction for investigation and experiment, while the probable benefits to man of a solution of the problem are so great that they are well worth striving for.

Success with aeroplanes, if it comes at all, is likely to be promoted by the navigable balloon. It now seems not improbable that the course of development will consist, first, in improvements of the balloon, so as to enable it to stem the winds most usually prevailing, and then in using it to obtain the initial velocities required to float aeroplanes. Once the stability of the latter is well demonstrated, perhaps the gas bag can be dispensed with altogether, and self-starting, self-landing machines substituted, which shall sail faster than any balloon ever can.

If we are to judge of the future by the past, such improvements are likely to be won by successive stages, each fresh inventor adding something to what has been accomplished before; but still, when once a partial success is attained, it is likely to attract so much attention that it is not impossible that improvements will follow each other so rapidly that some of the present generation will yet see men safely traveling through and on the air at speeds of 50 or 60 miles per hour.

THE LIVERPOOL OVERHEAD RAILWAY.

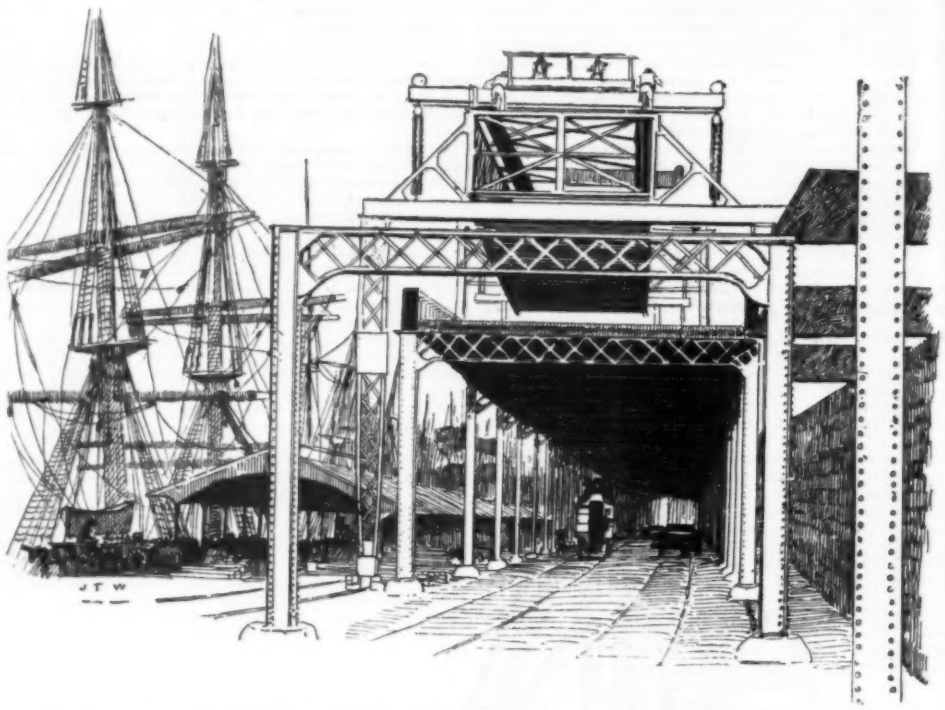
AN interesting function was recently performed at Liverpool in an inspection of the new overhead railway and the running of a trial trip along the length of line. The railway has entailed a total cost, including equipment, of £85,000 per mile. It has taken over three years to construct, and is so near completion that Lord Salisbury has consented to visit Liverpool on the 4th February to open it for traffic. The route extends from the Herculaneum Dock, which is almost opposite Eastham, away in a northerly direction for about six miles, terminating near the Rimrose Wall, at Seaforth, but there is provision for carrying the line some half mile further. There are thirteen stations, the northernmost being at the Alexandra Dock, and by and by a fourteenth will be erected at Seaforth. Although overhead railways have long been familiar objects in New York and other American cities, Liverpool has the distinction of possessing the first construction of its kind in England, and at the same time the first in the world planned on ordinary railway dimensions and worked by electricity. There are up and down tracks, the rails being set up to the regular railway gauge of 4 ft. 8 in., and the carriages are of the usual width, so that the work is on a far more important scale than a mere tramway. Originally the undertaking was promoted by the Dock Board with the object of facilitating passenger traffic about the dock estate, but in 1888 the powers of the board were conferred upon the company who are now the owners of the novel line, and also are looking forward to a profitable traffic in the immediate future. The shareholders, indeed, seem to be sanguine of their prospects in this respect, and it is at least certain that the greatly increased facilities it affords for traveling rapidly and in comfort, as compared with the present locomotion of the heavy, jolting dock omnibuses, must at once popularize the railway.

At Stanley Dock the most important engineering feature of the whole undertaking is met with. This is the only dock whose entrance is actually crossed, all the other docks being between the viaduct and the river. In this instance the difficulty has been met at a cost of £20,000 by a swing bridge of novel design, and worked hydraulically. The Stanley bridge, like the tilting bridges, will only be opened at night, but underneath it there is yet another bridge which can be swung during the daytime to allow flats to pass in and out of the dock. The 300 yards of railway already referred to passes with a dip and a corresponding rise on an earth embankment, and its appearance is in marked contrast to the miles of ironwork stretching away from it north and south. The stations are built upon iron girders and columns, the platforms being about 115 ft. in length by 12 ft. wide and 3 ft. above rail level. Access to the platforms is gained from the street level by four staircases at the more important stations, and on each platform a waiting shed is provided, with pay offices and turnstiles. We are indebted to the *Manchester Examiner* and the *Pall Mall Budget* for these details and sketches.

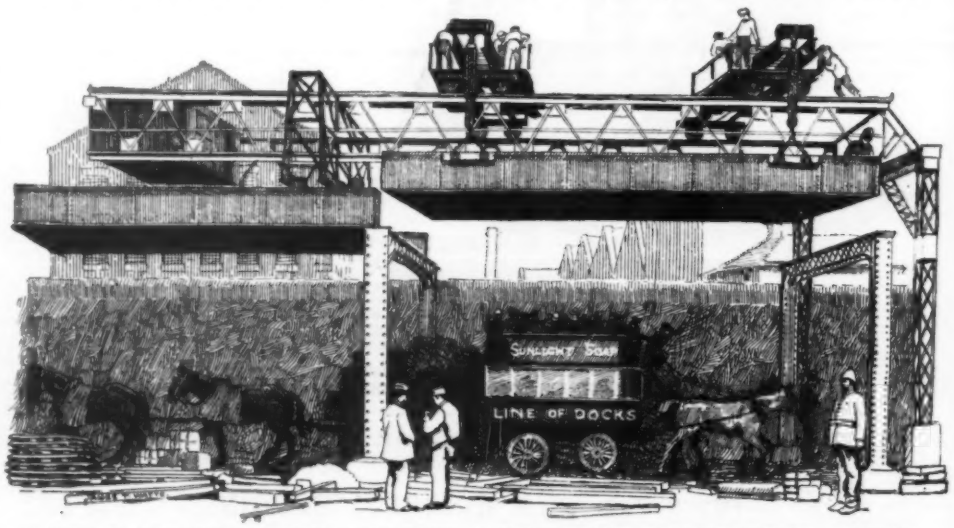
*I have refrained in this paper from discussion of the various mathematical formulæ concerning air resistances, because not only are they a matter of controversy, which must hereafter be settled by experiment, but also because the figures of M. Drzewiecki, which are based on empirical formulæ, may be in need of revision; for the benefit of the curious in such matters, however, it may be stated that his paper can be obtained (in French) in *L'Aeronaute* for October, 1889.

A STATION—LIVERPOOL OVERHEAD RAILWAY.

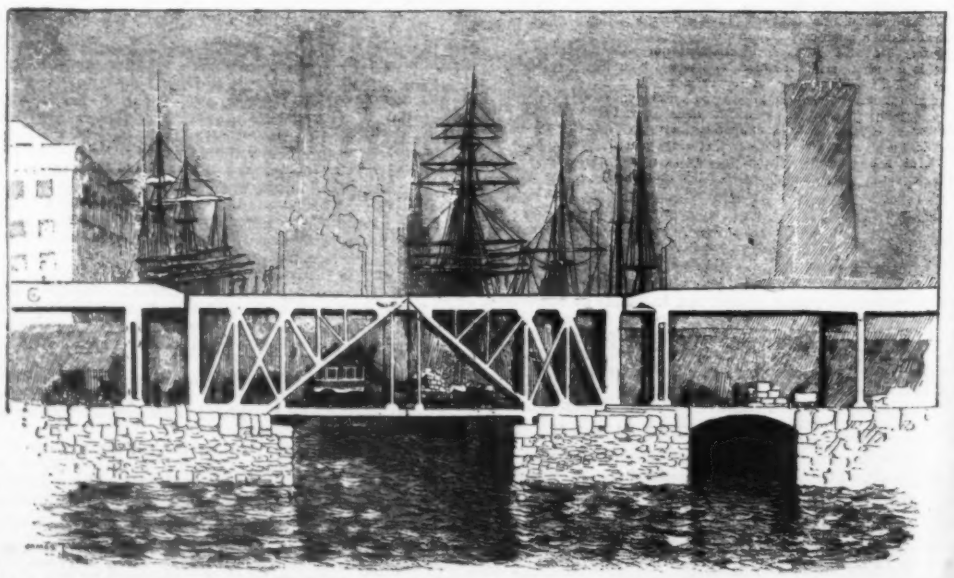
A CAR—LIVERPOOL OVERHEAD RAILWAY.



UNDER THE OVERHEAD RAILWAY—FRONT VIEW OF THE TRAVELING GANTRY.



THE TRAVELING GANTRY LOWERING A SOLID SPAN OF THE FLOOR OF THE OVERHEAD RAILWAY.



THE STANLEY SWING AND LIFT BRIDGE ON THE LIVERPOOL OVERHEAD RAILWAY.

THE MODERN IRON PLOW.

THE honor of the invention of the modern plow, with iron mould board, has been claimed by several different persons; but there is good evidence to support the claims of Joseph Smith, of Buckingham, Bucks County, Pa., as the original and first inventor, although the patent was granted to his brother, Robert Smith, on May 19, 1800.

The history of the plow and the particulars concerning Joseph Smith are given in Davis' "History of Bucks County, Pa.," published in 1876, also in the "Genealogy of Robert Smith." We make the following abstract:

In May, 1783, Robert Smith, Joseph Smith, Uriah Hughes, and Joseph Kinsey, all of Buckingham, entered into a co-partnership to erect an industrial establishment, to run by water. In 1784 Uriah Hughes was released at his own request, and his interest conveyed to Robert Smith. Joseph Smith, the moving spirit in this work, selected a forbidding spot on the bank of the Delaware, two and a half miles above Point Pleasant, where he caused to be erected four dwellings, grist and saw mill, and smith and plow shops, which gave employment to a number of men. The place took the name of Smithtown.

The plan for an iron mould board of proper curve and length was drawn by Joseph Smith, who had a rare faculty for mechanics. He had been giving attention a number of years to the best curve for a plow mould to turn a smooth furrow and of easy draught. The miniature models for a plow whittled out by him with a pocket knife for amusement years before, when there was nothing else to do, attracted attention to the man who made them.

At the new establishment he had now an opportunity of bringing his ideal plow to the test of a trial in the field, and went to work earnestly, feeling sure of success. As soon as he finished a pattern, it was taken to the foundry of Charles Newbold, below Camden, N. J., where it was used in making the first cast iron moulds. The castings were brought home and a plow finished ready for trial. The talk about the new plow during the progress of the work of making it excited much interest to see it in motion. On the day of trial a large crowd of people came to the field to see it turn a furrow. The result, as told to the writer by one who was at the trial, "It was a proud day for the maker of the plow."

The mechanical genius exhibited by Joseph Smith, in making a plow of so much importance to agriculture, led to a personal acquaintance with Thomas Jefferson and a number of other distinguished men of that day.

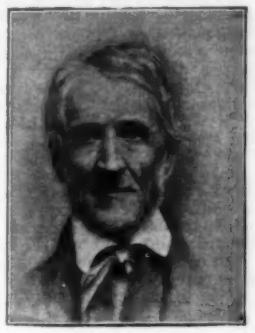
The pecuniary benefit of the patent, however, was very small compared with the number of iron moulds in use.

As soon as the superiority of the plow over the wooden mould became generally known over the country, they were made and sold at distant places, without regard to the patent.

It was found impossible to collect the royalty for the rights to make and sell the plows, except on those made comparatively near home.

The principal occupation at Smithtown was making plows and mould boards. Joseph Smith was assisted by his sons, Mahlon, Jonas, and Charles, and the father moved there in 1802. Joseph Smith had a rare faculty for mechanics. The idea of the plow had been in his mind for ten years, and he had made them three years before the patent was obtained. In 1803 they shipped 758 mould boards.

Joseph Smith introduced the use of hard coal in blacksmith shops in Bucks County, and taught others how to use it. In 1812 he sent his sons, Charles and Jonas—the former now living near Pineville, at the age of ninety—to Lehighton, for two wagon loads of coal. One load was left at Smithtown, to be used in the shops there, and the other was to be delivered to the three most noted blacksmiths in the county—Thomas Atkinson, of Wrightstown, then doing iron work for a chain bridge; Benjamin Wood, of Solebury, who followed smithing at Buckman's; and Edmund Kinsey, of Milton, near Carversville. They were unable to use the coal satisfactorily, and it took a good while to burn the load left at Smithtown. To keep the coal from choking up the draught, a nail rod was fixed to the roller of the bellows, so that at every stroke the air would run out of the tube into the fire and loosen up the coal.



JOSEPH SMITH.

In December of that year, Charles Smith, of Wrightstown, a son of Joseph, hauled thirty bushels of hard coal from Smithtown to his shop. It burned well at first, but in ten minutes the fire went out in spite of all he could do. That load of coal lasted three years, and until his father had discovered, by experiment, how to burn the coal in smith shops as it was burned at Wilkesbarre, but not until his son Jonas had invented a fixture which kept the coal ignited, with the iron heated to any degree of heat. Hard coal now came into general use in forges, and charcoal was supplanted. Charles Smith is said to have used it in his smith shop successfully, as early as 1813. In the Pennsylvania *Correspondent* of March, 1815, Joseph Smith, of Tinicum, publishes a card with directions how to construct a smith's fire to burn Lehigh coal in, and states that his own workmen can lay one-third more share moulds in the same time with Lehigh than with charcoal. Jacob B. Smith, of New Hope, and Edmund Kinsey, of Milton, certify to the truth of what he says, and Kinsey adds that "twenty-two pounds of Lehigh coal will go as far as thirty-three pounds of Richmond or soft coal." Lehigh coal then cost $24 a ton, and its use was thought to be economy. Joseph Smith died suddenly at the house of a relative, in Solebury, on his return home from a visit to his daughter, September 28, 1826, at the age of 73. His widow died in 1854, aged 100 years.

THE IRON MOULD BOARD PLOW.

Joseph Smith was a man of great activity and intelligence, strong mind and liberal views, and a philanthropist in the best sense of the word, and deserves to be remembered among the benefactors of his race. He learned the mechanical trade of his father.

Among other good deeds may be mentioned the introduction of clover seed into Bucks County, and the use of plaster of Paris on land, which have proved a source of wealth.

He left 59 grand-children at his death. His consistency, as a Friend, brought him into trouble during the stormy period of the Revolution, and he was arrested on two occasions, once being confined a prisoner in the American camp, and once in the Newtown jail. While in jail his wife visited him twice a week regularly, with provisions, traveling the distance, 16 miles, there and back, on horseback, alone.

After Joseph Smith's death, the plow works were carried on by his sons, Mahlon, Jonas, and Charles, until 1840, and by Mahlon at that and other places until 1870, who is still living in Tinicum, upward of 90 years of age. He made an improvement in the mould board after the patent was taken out, and the new pattern was followed for years, but never patented. The mills and most of the workshops were destroyed by the digging of the Delaware Canal, and Smithtown, except in name, has ceased to exist.

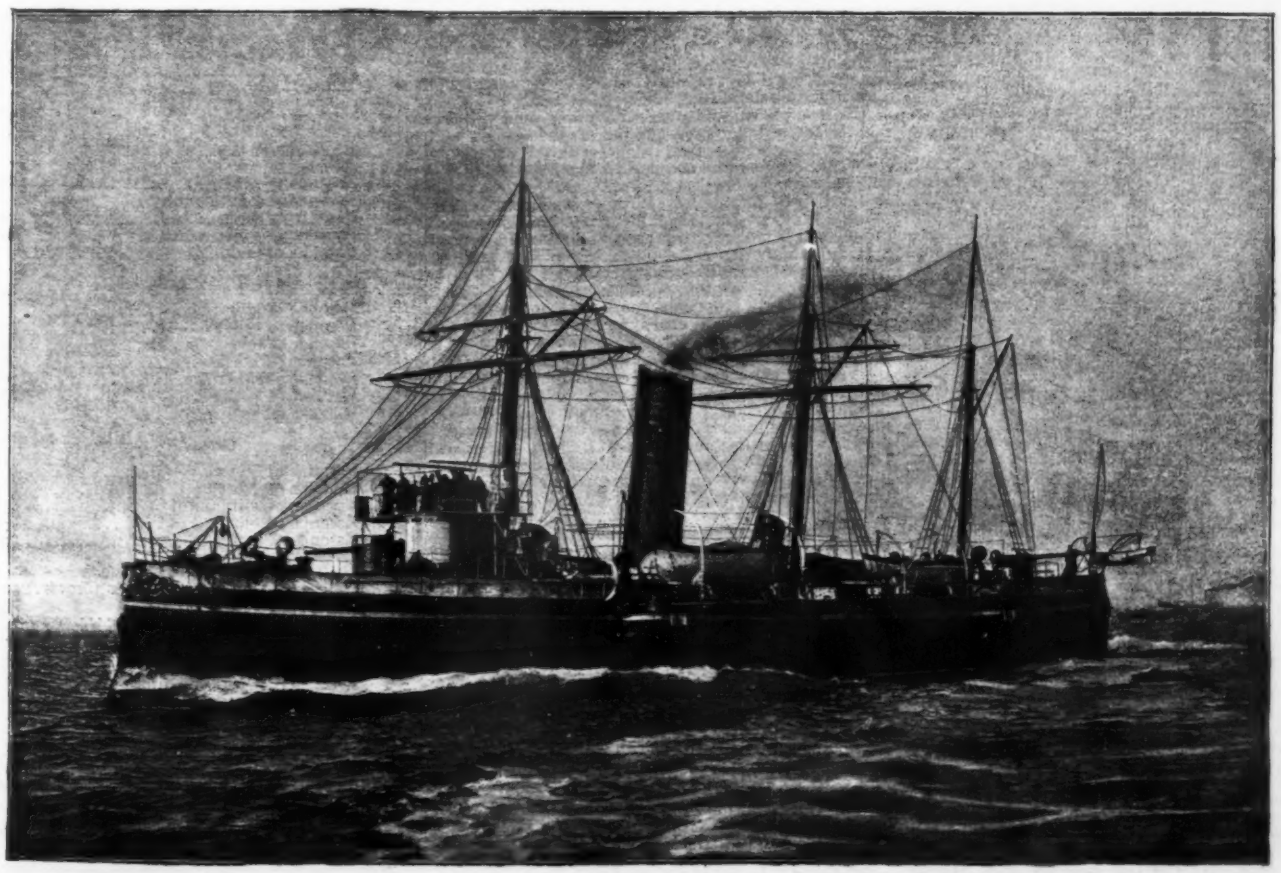
THE NEW BRAZILIAN CRUISER REPUBLICA.

SIR W. G. ARMSTRONG, MITCHELL & CO., Limited, of the Elswick Works, Newcastle-on-Tyne, have recently completed a new Brazilian cruiser, the Republica. This vessel is of 1,300 tons displacement, she has an extreme length of 226 ft. 6 in., and a beam of 35 ft. Her engines developed 3,400 horse power, with forced draught, and the speed attained was 17·4 knots per hour. She ran her speed trials and carried out her gunnery trials off the mouth of the Tyne in November last. There was considerable swell at the time, but, in spite of this, she made four runs at the measured mile with a speed of 17·4 knots, the contract speed being 17 knots. The engines were built by Messrs. Hawthorn, Leslie & Co., of Newcastle-on-Tyne.

Five rounds with cordite smokeless powder from each of the six 4·7 in. quick firing guns were considered enough to prove the gun mountings and fittings, especially as very exhaustive trials had so recently been carried out from similar guns on board the Brazilian third-class cruiser Tiradentes.

The gunnery trials of the Republica passed off without any incident, everything in connection with guns and mountings working perfectly.

The preliminary trials of the 6 in. gun and mounting were of a most exhaustive nature; 350 rounds were fired from one gun and mounting without a mishap before any orders were placed. The 6 in. Elswick gun and mounting have now become service fittings, and we have the Royal Sovereign in commission with ten such guns, and several other ships have completed their firing trials with them. In all cases perfect satisfaction has been given.—*Engineering.*



THE NEW BRAZILIAN CRUISER REPUBLICA.

SEPARATION OF SILVER AND LEAD.

By R. BENEDICT and L. GAUS.

THE authors found their process on the different behavior of silver and lead iodides with dilute nitric acid.

The solution containing silver nitrate and lead nitrate—in all about 0·5 gramme of metal—is diluted with cold water in a capacious glass capsule to from 200—300 c. c., and solution of potassium iodide more than sufficient for the complete precipitation of the silver, but not excessive in quantity, is allowed to flow in. If 0·5 gramme of metal is used, 10 c. c. of a 10 per cent. solution of potassium iodide will be sufficient in any case. We then add 10 c. c. of nitric acid free from chlorine, previously diluted with from 10—20 c. c. of water. The capsule is then covered with a watch glass and heated on the water bath, when the yellow color of the precipitate chiefly passes at first into orange red.

As soon as the liquid has become hot, the lead iodide dissolves, the liquid becomes dark brown, and vapors of iodine are given off. The watch glass is then removed and rinsed into the capsule, boiling water is added, and the capsule is left on the water bath, adding water from time to time to compensate for the loss by evaporation until the liquid has become colorless or pale yellow, when the iodine is expelled. The silver iodide is then weighed. The authors collect it in a small glass tube filled with glass wool, dried at 110°, and weighed. Wash it first with hot water containing nitric acid and then with a few c. c. of hot water, dry at 110° and weigh.

The presence of other metals of the same group, with the exception of mercury, does not interfere. Cuprous iodide, bismuth, and cadmium iodide behave with nitric acid like lead iodide; on the other hand, mercurous iodide is converted into red iodide, which is not further attacked.

The authors publish very favorable results. In the examination of alloys of lead and silver they proceed in the same manner. They dissolve in nitric acid, dilute, precipitate with potassium iodide, and heat on the water bath.

For determining silver in impure leads, from 10—50 grammes of the same, according to the proportion of silver, is dissolved in dilute nitric acid containing tartaric acid. To 10 grammes of the sample they use 10 c. c. nitric acid free from chlorine, and an equal quantity of a saturated solution of tartaric acid. The presence of the latter effects much more rapid and complete solution. The solution is heated until the oxidation is completed, diluted with boiling water, filtered into a glass capsule, diluted to from 300—500 c. c., allowed to cool, 10 c. c. of a 10 per cent. solution of potassium iodide are added and it is heated on the water bath.

The excess of the nitric acid added for solution is generally sufficient for oxidizing the lead iodide; if the development of iodine vapors and the brown color do not appear, a little more dilute nitric acid must be added.

The proportion of silver in galena may be determined in the same manner. It is oxidized with nitric acid with the addition of tartaric acid. It is most convenient to use equal volumes of nitric acid, solution of tartaric acid, and water. After the oxidation is completed, the liquid diluted with hot water, filtered, and well washed with boiling water, the filtrate is allowed to cool. The process is then completed as above.—*Zeit. Anal. Chemie and Chem. Zeitung; Chem. News.*

A VOLATILE SERIES OF METALLIC COMPOUNDS.

By C. F. TOWNSEND, F.C.S.

THE progress of chemical science is continually bringing to light new wonders and startling paradoxes. Nothing more remarkable and unexpected has occurred in the recent history of chemistry than the discovery of the compounds of nickel and iron with the gas generally known as carbon monoxide or carbonic oxide. The new compounds are called respectively nickel and iron carbonyls, and have evidently a great future before them. Judging from chemical precedent, one would quite as soon have expected oil and vinegar to form a homogeneous mixture as a combination of the bodies referred to. In fact, so anomalous did it appear when Mr. Ludwig Mond first brought the accidentally discovered nickel compound to the notice of the Chemical Society in the middle of 1890, that many almost refused to believe in the possibility of its existence. However, there is no doubt about it. Nickel carbony, a considerable quantity of which was exhibited at a *conversazione* of the Royal Society held in June last, and also at the meeting of the British Association, is obtained by merely passing carbon monoxide—a product of the incomplete combustion of coke or charcoal, and which may often be seen burning with a lambent blue flame at the top of a clear fire—over the finely divided metal, and condensing the resulting vapor in a tube surrounded with ice and salt. Its properties have been very fully investigated both by its discoverers, Messrs. Mond, Langer and Quincke, and also by M. Berthelot, who published his results in the *Comptes Rendus.*

It is a liquid of very high refractive power and brilliant appearance, and considerably heavier than water, under which it may be kept without change, provided the vessel is completely filled and the water contains no air. It solidifies at 13° F., and boils at 109° F., and the vapor, if lighted, burns with a strongly luminous flame, which appears smoky in consequence of the separation of metallic nickel. The liquid is very volatile, and if the vapor is suddenly heated, a sharp detonation is caused. A mixture of nickel carbonyl with air takes fire, if brought into contact with a very hot body, and occasionally explodes. A mixture of the dry vapor and oxygen may be detonated by simple agitation over mercury, and strong oil of vitriol produces the same effect in a few minutes. The vapor, when heated to 358° F., splits up again into its original constituents, the metal and the gas, and the nickel deposits itself as a brilliant coating on the sides of the vessel. Advantage is taken of this circumstance to apply the carbonyl to nickel plating, and a patent has been taken out by its discoverers for working it on a commercial scale. At the last meeting of the British Association, Mr. Ludwig Mond described the various uses to which the discovery might be put, and the possibilities which it opened up. The nickel plating can be accomplished by simply exposing the goods, after being heated to the temperature just mentioned, to nickel carbonyl vapor, and solid articles can be similarly formed by passing the vapor through heated moulds. For this purpose, it is found advantageous to dilute the vapor considerably with air. Nickel can also be deposited on any substance by treating it with the liquid itself, or better, by nickel carbonyl dissolved in suitable solvents. These processes possess a great advantage over electro-plating, as not only metal but any substance, however intricate in design or fragile in structure, can be coated with a brilliant film of nickel by its means without the tedium and risk of first covering it with a surface of blacklead. Some very beautiful specimens of real flowers, plated with different metals, principally gold and silver, so as to bring out the various parts of their structure, were exposed for sale at the Frankfort Electrical Exhibition. A syringa blossom, for instance, would have its stamen and anthers plated with gold, its corrolla with silver, and the stalk and calyx with copper. Needless to say, they found a ready market. The field before this new process is practically unlimited, for not only could it be applied to ornaments and articles of household use, but, if required, to delicate muslins, and dress or other fabrics.

The liquid nickel carbonyl is highly poisonous, and, if injected subcutaneously, acts very powerfully on the animal system, producing an immediate and remarkably prolonged fall of temperature. It might, perhaps, be introduced into medical practice as an antipyretic in the treatment of fevers, were it not for the difficulty of administering it in sufficiently small doses, and its intensely poisonous action. The carbon monoxide alone is the active agent in causing this effect, the symptoms being those of respiratory poisoning; and the blood of animals killed by it exhibits the same appearances as that of persons suffocated by inhaling the fumes of burning charcoal. This kind of poisoning is particularly dangerous, and in cases of recovery the effects do not wear off for several hours after. The red corpuscles of the blood owe their color to a complex chemical substance known as hæmoglobin, which acts as the carrier of oxygen. In passing through the lungs oxygen is taken up, and it is converted into oxyhæmoglobin, which, when placed so as to intercept the rays of light in the spectroscope, gives quite different absorption bands to the hæmoglobin itself; from the lungs the oxygen is carried to different parts of the body to be exchanged for carbonic acid, which is brought back to be eliminated and again replaced by oxygen, thus completing the cycle. Carbonic oxide combines with the hæmoglobin to form carboxy-hæmoglobin, an exceedingly stable substance, which can only be displaced by oxygen with the greatest difficulty. The consequence is that the blood is unable to perform its functions, and the animal rapidly dies from suffocation. The absorption spectrum of this last body is remarkably characteristic and quite unmistakable, forming an infallible test in case of suspected poisoning by charcoal fumes. The vapor of nickel carbonyl is as deadly as the liquid, and is dangerous in air even to the extent of only 0·5 per cent.

The extraction of the metal from its ores is another valuable use to which the discovery of this compound will almost certainly be put. The principal sources of nickel are the copper colored arsenical mineral which the German miners—after working it unsuccessfully for years in the hope of obtaining copper—called *kupfer-nickel* (*i. e.*, false copper), and in which the metal was first discovered by Cronstadt in 1751, and *speiss*, an impure residue formed at the bottom of the melting pots in the manufacture of the bright blue pigment known as *smalt*, which is largely used by paper stainers. Metallic nickel is obtained from these by heating them with charcoal in a furnace, but the product only contains about 60 per cent. of the pure metal. It appears now that it will be sufficient to pass carbon monoxide over the crushed mineral, and by simply heating the resulting nickel carbonyl to 358° F. chemically pure nickel will be deposited.

All attempts to obtain a similar compound with other metals for a long time proved unsuccessful. As it seemed improbable that nickel should be the only metal forming such a compound, the investigators persevered with the work, and finally succeeded in volatilizing distinct quantities of iron in a current of carbon monoxide. The issuing gas burned with a yellowish flame, and if passed through a heated tube deposited a metallic mirror in the glass, which answered to all the tests for iron with unusual brilliancy. The quantity produced was, however, very small, and the process exceedingly laborious, for it took no less than six weeks to volatilize about thirty grains of iron. Even under the most favorable conditions the gas never contained more than 0·2 per cent. of the compound, but by varying the details of the process a much larger yield was obtained.

The iron carbonyl thus produced is a pale yellow viscous liquid, nearly half as heavy again as water. It distills without decomposition at 220° F., and solidifies below 6° F. into yellowish needle-shaped crystals. It decomposes slowly on exposure to air and, like the nickel compound, is completely broken up by heating its vapor to 356° F. On the other hand, it is much less active than its analogue and is not attacked by dilute oil of vitriol. Its composition was at first thought to be similar to that of nickel carbonyl, but on accurate analysis it was found to contain five proportions of carbon monoxide [$Fe(CO)_5$] instead of the four which constitute the latter [$Ni(CO)_4$].

While engaged in some experiments on the utilization of water gas (which is manufactured by passing steam over red hot coke, and contains about 40 per cent. of carbonic oxide) for illuminating purposes by means of the Farnehjelm system, in which a comb of magnesia is raised to incandescence by a number of fine gas jets, Sir H. E. Roscoe and Mr. Scudder noticed that a red deposit of oxide of iron was formed on the rods after the water gas had impinged on them for a few hours.

This was a serious drawback, as the illuminating power became much reduced. As the experiments were being conducted in a steel works, the first supposition naturally was that the stain was caused by fine particles of iron present in the atmosphere, but closer inspection showed that the deposit was of a "coralloid" structure and must, therefore, have been produced by the gas itself. In order to ascertain whether the iron existed in the gaseous state or was carried forward chemically, the gas was filtered through several tight plugs of cotton wool. No difference whatever was observed, and it was concluded that the gas contained a very minute quantity of a volatile compound of iron. Shortly after it was subjected to various chemical tests, which left very little doubt as to its identity with iron carbonyl.

Coal gas has also been found to contain iron, derived, no doubt, from the slow action of the 7 or 8 per cent. of carbon monoxide it contains on the iron of the mains and gas pipes. This accounts for the hitherto unexplained black stain so frequently observed on steatite and other burners. Compressed coal gas has begun to take the place of hydrogen in the production of lime light, and the stain formed on the lime cylinders is very noticeable, being, it is almost needless to say, somewhat of a drawback to its use.

The discovery of this series of compounds is quite a revelation to the metallurgical chemist, and already explains many mysteries. In the cementation process for the manufacture of steel, bars of iron are embedded in powdered charcoal, and kept at about the melting point of copper (2,192° F.) for eight or ten days. Steel, as is well known, is an alloy of iron, with a combination of carbon and iron, called carbide of iron, and the principle of all steel making is the same: carbon must be added to soft iron in definite proportions. If the iron contains no carbon, it is comparatively soft and malleable. Wrought iron contains less than 0·3 per cent. of carbon; steel from 0·8 to 1·5 per cent. Above this the metal takes the character of cast iron. The charcoal which surrounds the bars of iron in the process just referred to occludes a large quantity of air in its pores, which, when heated, forms carbonic oxide. This gas permeates the iron and gives up its carbon to the metal, returning again to take up a fresh supply from the charcoal, and thus acts as a carrier of carbon to and fro in the interstices of the iron, which it gradually converts into almost homogeneous steel, known technically as *blister steel*, owing to its peculiar vesicular appearance caused by the penetration of the gas. These compounds must play a very important part too in the blast furnace and in both the Siemens and the Bessemer process, especially the latter. Bessemer steel is made from cast iron; the carbon and impurities are burnt out of it by driving a current of air through the molten metal. When this has been accomplished, a highly carbureted cast iron, called *spiegeleisen*, is thrown into the converter in properly regulated quantity, and the carburation of the iron is rapidly effected.

Renewed attention has recently been directed to some volatile compounds of platinum with chlorine and carbon monoxide, which are broken up by water with deposition of pure platinum, thus forming a possible way of extracting the metal from its ores. If any discovery of this kind were to facilitate the extraction of gold, which at its present rate can barely keep up with the demands of the increasing consumption, an immense boon would be conferred on the civilized world.—*Knowledge.*

THE MANUFACTURE OF LIQUORS AND PRESERVES.*

By J. DE BREVANS, Chief Chemist of the Municipal Laboratory of Paris.

PART II.—CHAPTER V. (*Continued.*)

SECTION III.—SUPERFINE LIQUORS.

Liqueur surfines.

THE quantities of alcohol (85°), sugar, and water usually employed in the preparation of superfine liquors are:

Alcohol (85°)	3 l.
Sugar	5 k. 500 grm.
Water	2 l. 600 c. c.

For 10 l.

Cream of Absinthe.
Crême d'absinthe.

Essence of absinthe	0·6 grm.
Essence of English mint	0·6 grm.
Essence of anise	3 grm.
Essence of sweet fennel	0·8 grm.
Essence of lemon distilled	3 grm.

Anisette.

Essence of star anise	7 grm.
Essence of anise	2 grm.
Essence of sweet fennel	0·8 grm.
Essence of coriander	0·1 grm.
Essence of sassafras	0·6 grm.
Extract of orris	6 grm.
Extract of ambrette	0·8 grm.

Crême de Barbades.

Essence of lemon, distilled	6 grm.
Essence of Portugal, distilled	3 grm.
Essence of cinnamon of Ceylon	0·4 grm.
Essence of cloves	0·4 grm.
Essence of nutmeg	0·2 grm.

Chartreuse.
Liqueur de la grande Chartreuse.

Essence of lemon balm	0·2 grm.
Essence of hyssop	0·2 grm.
Essence of angelica	1 grm.
Essence of English mint	2 grm.
Essence of Chinese cinnamon	0·2 grm.
Essence of nutmeg	0·2 grm.
Essence of cloves	0·2 grm.

Color, yellow or green.

Curaçao.

Essence of curaçao, distilled	10 grm.
Essence of Portugal, distilled	4 grm.

Bitter infusion of curacao a sufficient quantity; color with Pernambuco wood.

* Continued from page 14239, SUPPLEMENT No. 893.

Kirschenwasser.

Huile de Kirschwasser.

Essence of noyaux	4 grm.
Essence of French nerole	0·4 grm.

Cream of Orange Flowers.

Crême de fleurs d'orangers.

Essence of French neroli	2 grm.
Orange flower water	0·2 l.

Crême de Menthe.

Essence of English mint	6 grm.

Liquor of Mézenc.

Essence of nutmegs	0·2 grm.
Essence of mace	0·2 grm.
Essence of camomile	1 grm.
Essence of daucus	0·5 grm.
Essence of coriander	0·3 grm.
Myrobolans	6 grm.
Ambrette (seed musk)	6 grm.
Vanilla	6 grm.

After the essences are dissolved, infuse the last three substances in alcohol for 15 days; color with Pernambuco wood, add a few drops of a solution of tartaric acid to brighten up the color.

Crême de roses.

Essence of roses	1·5 grm.

Color with cochineal.

Crême de noyaux de Phalsbourg.

Essence of apricot seeds	5 grm.
Essence of bitter almolds	1 grm.
Essence of Portugal, distilled	1 grm.
Essence of lemon, distilled	0·8 grm.
Essence of Chinese cinnamon	0·4 grm.
Essence of cloves	0·2 grm.
Essence of nutmegs	0·1 grm.
Essence of neroli	0·2 grm.

Vespétro de Montpellier.

Essence of anise	4 grm.
Essence of caraway	3 grm.
Essence of fennel	8 grm.
Essence of coriander	0·4 grm.
Essence of lemon, distilled	2 grm.

Anisette de Hollande.

Essence of star anise	5 grm.
Essence of anise	5 grm.
Essence of bitter almonds	0·8 grm.
Essence of coriander	0·1 grm.
Essence of fennel	0·2 grm.
Essence of roses	0·2 grm.
Essence of angelica	0·4 grm.

Alkermès de Florence.

Essence of calamus	0·3 grm.
Essence of cinnamon, Ceylon	0·2 grm.
Essence of cloves	0·5 grm.
Essence of nutmegs	0·3 grm.
Essence of roses	0·4 grm.
Extract of jasmine	3 grm.
Extract of anise	3 grm.

Rosolio de Turin.

Essence of anise	2·5 grm.
Essence of fennel	0·3 grm.
Essence of bitter almonds	3 grm.
Essence of roses	0·6 grm.
Extract of ambergris	0·4 grm.

Color with cochineal.

Marasquin de Zara.

Essence of noyaux	3·5 grm.
Essence of neroli	0·5 grm.
Extract of jasmin	1 grm.
Extract of vanilla	1·5 grm.

Crême d'heliotrope.

Extract of heliotrope	18 grm.

Color a clear rose, with cochineal.

Crême de jasmin.

Extract of jasmin	15 grm.

Color with caramel.

Crême de jonquille.

Extract of jonquille	14 grm.

Color with caramel.

Crême de millefleurs.

Essence of neroli	0·5 grm.
Essence of roses	0·2 grm.
Extract of jasmin	2 grm.
Extract of jonquille	1·5 grm.
Extract of heliotrope	2·5 grm.
Extract of reseda	2 grm.
Extract of tuberose	2 grm.

Crême de réséda.

Extract of reseda	17·5 grm.

PART II.—CHAPTER VI.

Aromatic Wines and Hydromels.

Under the name hydromel are included many drinks which have almost passed almost out of use, the base of which is honey. These liquors are little used in France, and are principally made and consumed in northern countries. The following is one of the best known receipts:

White honey	15 k.
Cream tartar	500 grm.
Elder flowers	500 grm.
Pressed brewer's yeast	500 grm.

Make an infusion of the elder flowers in 100 l. of boiling water, a quarter of an hour afterward add the cream of tartar. When the infusion commences to cool (about 30° C.) add the honey and the yeast: place all in a vessel having a constant temperature of 18 to 22°. The liquor ferments, and when the effervescence has ceased, draw off the liquor and cork tightly. The elder flower can be replaced with other aromatic substances, such as thyme, rosemary, sage, etc.

Hippocras.

Hippocras was formerly very celebrated, but is rarely used at the present day. The following receipt for white hippocras will suffice, as this liquor is rarely or never made at the present day. The receipt is from *Le Confiseur royal* (1737). Take two pints of good white wine, a pound of sugar, an ounce of cinnamon, a little mace, two grains of white pepper (whole), and a lemon divided into three parts; let the whole infuse some time; run through a filtering bag held open by two little sticks; pass through three or four times. If the liquor does not filter easily, add half a glass of milk, which will produce the desired effect. You can give the odor of musk and ambergris to the hippocras by adding a crushed grain or two to the sugar, or enveloped in cotton and attached to the point of the filter.

Cherries.

Vin de cerises.

Cherries	25 k.
Currants	5 k.

Crush all in a small cask; allow it to ferment for three days, and add 500 c. c. of alcohol (80°); at the end of six days the clear liquid is drawn off, and to each l. 5 k. of sugar are added. The wine is then put in a tun with spices, mace, pepper, cinnamon, coriander, etc., according to taste.

Cider.

Vin de pommes.

A liquor is prepared in the United States which, when old, recalls Rhine wine. It is made by taking ripe apples, pressing and gathering the juice, evaporating to half; when cold add sufficient brewer's yeast to develop a brisk fermentation; after twenty-fours draw off and place in barrels, or, better, bottle.

Vermouth of Turin.

Vermouth de Turin.

Vermout de Torino (Italian).

Large absinthe	125 grm.
Gentian	60 grm.
Angelica root	60 grm.
Holy thistle (*Centaurea benedicto*)	125 grm.
Calamus aromaticus	125 grm.
Elecampane	125 grm.
Lesser centaury	125 grm.
Lesser germander	125 grm.
Chinese cinnamon	100 grm.
Nutmegs	15 grm.
Sliced fresh oranges	6 grm.
Sweet wine of Picpoul	95 l.
Alcohol (85°)	5 l.

Infuse or digest for five days, draw off, size with fish glue, allow it to repose for eight days, size again and bottle.

Receipt for Vermouth Ollivero.

Coriander	500 grm.
Bitter orange peel	250 grm.
Powdered orris	250 grm.
Elder flowers	200 grm.
Cinchona (red)	150 grm.
Calamus	150 grm.
Large absinthe	125 grm.
Holy thistle (*Centaurea benedicto*)	125 grm.
Elecampane	125 grm.
Lesser centaury	125 grm.
Lesser germander	125 grm.
Chinese cinnamon	100 grm.
Angelica roots	60 grm.
Nutmegs	50 grm.
Galanga	50 grm.
Cloves	50 grm.
Cassiæ	30 grm.
White wine of Picardy	100 l.

Infuse for five or six days, size with fish glue, and repose for fourteen days. For a vermouth of the best quality, add 2 l. of an infusion of toasted bitter almonds and 3 l. of good cognac.

First Quality Vermouth.

Clean absinthe	500 grm.
Small absinthe	500 grm.
Cinchona (red)	500 grm.
Florentine orris	400 grm.
Veronica	500 grm.
Liverwort	500 grm.
Holy thistle	500 grm.
Elder flowers	500 grm.
Rhubarb	60 grm.
Ripe orange peel	500 grm.
Curacao peel	125 grm.
Peach stones	500 grm.
Orange flowers	250 grm.
Semen-contra	50 grm.
Lesser centaury	125 grm.
Lesser germander	125 grm.
Cognac (40°)	16 l.
White sugar dissolved in the wine	6 k.

Infuse for two months, agitate daily for fifteen days, draw off, size, put the vermouth in bottles. The wine of Picardy is preferable.

Vermouth au madère.

Large absinthe	125 grm.
Angelica roots	60 grm.
Holy thistle	125 grm.
Liverwort	125 grm.
Veronica	125 grm.
Rosemary	125 grm.
Rhubarb	30 grm.
Cinchona (red)	200 grm.
Powdered orris	250 grm.
Infusion of curacao	25 c. c.
Madeira wine	93 l.
Grape sirup	3 l.
Cognac (40°)	5 l.

Digest for three days, draw off the clear liquid, size with fish glue; after eight days of repose draw off size anew, draw and place in bottles.

(To be continued.)

THE DIFFERENT METHODS OF DYEING WOOL.

By MAX BREITER, in *Faerberei Muster-Zeitung.*

THE capacity of the animal fiber to absorb dissolved dyestuffs from the bath, without the employment of an agent, enables the wool to be dyed by the simple introduction into, and appropriate treatment in, the heated solution. The coating becomes so heavy that it cannot be removed by simple washing, and to some extent, also, it resists the action of soap and other similar agents, but the dyeing process differs when the dyestuff is generated by the action of one agent upon another, which are respectively termed the dyeing principle and the mordant. In such cases the dyeing process varies according to the nature of the substances employed and according to the result to be effected.

By the first method—*the simple dyeing method*—the soluble dyestuff is simply absorbed by the wool fiber, and the boiling temperature augments the absorbent capacity. The gradual raising of the heat to the boiling point insures the equal coloring of the wool. Nearly all the artificial dyestuffs may be fixed in this manner.

By the second method—*the mordanting method*—the wool is first impregnated with a solution of the mordant, generally a metallic salt, after which the mordanted wool is entered into a solution of the actual dyestuff.

The third process—*the developing or saddening method*—is a reversal of the previous one, the immersion of the wool in the dyestuff solution taking place before the mordanting bath. Usually the mordant is added to the exhausted dye bath.

The fourth process—*the one-bath method*—is similar to the *third process*, but differs in one feature. A color lake, insoluble itself, but made soluble by proper agents, is introduced directly into the bath. The dyeing of black on wool, with logwood and potassium bichromate, will serve as an illustration of the *mordanting method*, which is used for the greater part of the woods, as well as for the so-called natural dyestuffs, in combination with different chrome, iron, tin and alumina mordants, and is almost exclusively employed for dyeing with the alizarine colors. The wool is mordanted at boil with 3 per cent. potassium bichromate, with a trifling addition of sulphuric acid, and boiled for from one hour to one hour and a half hours, after which it is washed and dyed with from 30 to 50 per cent. logwood. The result is a nice blue black, which, with a percentage of fustic, changes into a deep or coal black, or, with a larger quantity, into a green black. Dyeing with other dyestuffs and mordants is performed in an analogous manner. The great advantage of this method, without taking into account the great saving of dyestuff, as both mordanting and dye baths can be preserved for future use, is that full and fast shades are obtained on the wool. The fastness is perhaps due to the deep penetration of the mordant, the formation of the color lake being more in the interior of the fiber than upon its surface, thus offering a greater resistance to injurious influences. Another advantage is the ease with which the color may be shaded. If the dye bath has been kept a little paler than the desired shade, the dyeing of a swatch shows at once if the shade has been matched, and indicates what ingredients, if any, are to be added to the bath. The *saddening or developing method* is rather more limited in its range of application, but it has the advantage of saving much time, and thus cost, while its drawback is the loss of dyestuff, as the remainder of the bath, because of the mordant introduced, must be thrown away. The colors produced by this method are not so fast as those obtained by the mordanting process. The shading also requires an extensive experience in dyeing, since the color must be dyed previous to the saddening. A corrective dyeing can take place, after the saddening, only by using a large excess of dyestuff, for the reason that a small quantity of it would exert no influence whatever, owing to the excess of mordant, and would only result in producing a precipitate which, again, is soluble only in an excess of the mordant. Hence, additional dyestuff and mordant would have to be used, thereby causing much loss of these materials. When other dyestuffs, however, such as indigo, carmine, or tar colors—substances which dye without further mordanting—are added to the bath, it is done at the expense of fastness, and this, of course, is injurious to many colors that are intended to be fast against fulling.

When the saddening is done in a separate bath, as with cutch colors, the method becomes a direct reversal of the mordanting process. Take, for instance, the dyeing of colors, fast against fulling, with camwood or barwood in combination with other dyewoods, as an illustration of this method. It is the difficult solution of the dyestuff that necessitates the previous saddening. When, therefore, it is desired to produce red-brown and similar colors by the saddening method, it is necessary to boil from one to one and a half hours with from 30 to 80 per cent. of dyewood, and to sadden with from 1¼ to 2 per cent. potassium bichromate, and, for certain shades, a trifling percentage of alum in addition.

We now come to the fourth—*one-bath method*. As with the aniline colors, we here deal with a prepared color lake, which is soluble only in the dye bath by means of an acid, generally oxalic acid. This method is often used for dyeing black, or the so-called direct black. The dyeing substance is a color lake, precipitated either by sulphate of iron or copper, in the form of a paste, from a logwood decoction. This, together with a certain quantity of oxalic acid, is added to the bath.

The wool is boiled in this mixture of dark-brown color lake solution for from one to two hours, until the black is developed. Fustic, or logwood extract, may be used for shading. A chrome black produced according to this method is offered to dyers. It is a logwood decoction, boiled with potassium bichromate in correct proportion. The precipitate is collected and is used as a dyestuff in an oxalic acid solution. This chrome black, however, is inferior to the direct black.

The one-bath method may be used for all those color lakes which can be dissolved in the dye bath. For instance, it is employed for cochineal and tin chloride,

fustic and tin chloruret, alizarine and alumina mordants.

The advantages of this method are easily appreciated, because the dyer obtains the most speedy results by the simplest means. As regards fastness, these colors are largely inferior to those obtained by the mordanting process, but this feature is frequently of secondary importance and, therefore, the method can be pronounced very simple and cheap.

There is a fifth way of dyeing wool. This is the *combination of the mordanting and the saddening methods.* The following example is an illustration: To produce a black that will resist a strong fulling, first dye a chrome black according to the mordanting method, and, after the dyewood bath, enter the wool in a weak warm solution of potassium bichromate. This causes a more complete oxidation and fixation of the loosely adhering color particles, and produces a thorough fastness against fulling. This method may also be employed for other colors; for instance, mordant with 2 per cent. potassium bichromate, and dye in from 30 to 80 per cent. camwood. Then draw through a ½ per cent. weak chrome solution. This method is highly recommended for black or dark colors on yarn which is to be woven with light or white yarn and afterward fulled, for, in such cases, a smutting or bleeding of the colors must be absolutely avoided. Although particles of colors dyed after this process may peel off, they cannot be absorbed by the lighter colors, but drop off in the rinsing, because they then form a firm color lake.—*Textile Industries.*

A CHINESE SYSTEM OF GOLD MINING.*

By HENRY LOUIS, A.R.S.M., etc.

THE district of Tomoh, one of the Siamese-Malayan states, has been worked for gold by the Malayans and Chinamen for 150 years. The methods pursued are, of course, exceedingly primitive, but a record of them will be useful in compiling a history of gold mining and gold milling. In early times the Malayans used to work the alluvial deposits for gold, but, after these deposits had been exhausted, they ceased regular operations, because they did not relish the continuous hard labor requisite in working the quartz reefs. Immigrant Chinamen afterward appeared on the scene and

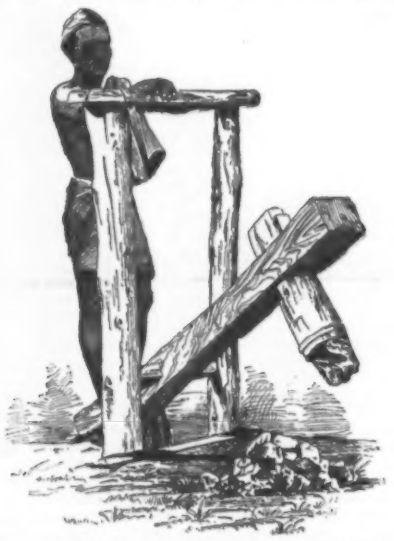


FIG. 1.—CHINESE FOOT POWER MILL.

applied their energies with success. Every now and then the Malayans would descend on the Chinamen's camp and exterminate it. This they did partly for recreation and partly to capture the proceeds of the Chinamen's hard work. Such disasters did not prevent other companies of immigrants from coming to the gold fields; and so, with a few breaks of this kind, the deposits have been worked continuously to the present day. Very few Europeans have ever been allowed to come near the workings; in fact, I believe that I was only the fourth foreigner that had ever been there.

This gold occurs in narrow veins and leaders of quartz intersecting and intercalated among irregularly upheaved and contorted highly metamorphosed micaceous and chloritic schists. The veins vary from three inches to three feet in thickness and are sometimes very rich. The extreme heat and moisture of the climate have in many places changed the rock to soft red, purple and yellow clays to great depths. In mining the gold a small water furrow is first brought in at the highest possible level on a suitable hill side, and the stream is turned down the hill. By means of this stream and a heavy iron-shod crowbar the earth and surface rock are broken and sluiced away. Any pieces of gold-bearing quartz that are seen in the tail race are picked out, but hardly any efforts are made to recover the loose gold. The surface of the shales which have been laid bare by the cowbars and water current are then searched for quartz veins. The quartz is dug out by rude picks and carried in baskets to the crushers. The excavations generally go in an upward direction into the side of the hill, but they cannot go far, on account of the impossibility of preserving timbers in such a damp climate. The work of mining is done very slowly; a party of 27 miners, on my visit, considered half a ton of quartz as a very satisfactory day's output.

The quartz on being extracted is broken with hammers so as to pass a 1½ in. ring and is then carefully hand picked to separate the apparently barren rock from pieces showing visible gold and sulphurets. I say "apparently" barren rock because on assaying many samples of this refuse I have found from three to ten pennyweights per ton in it. The crushing of the ore is effected by tilt hammers, worked either by foot power (as in Fig. 1), or by water power (as in Fig. 2). The foot power hammer is the older type; and the water power mill, in batteries of from three to six hammers, was introduced first about twelve years ago. The foot power mill is made entirely of wood, with the exception of the hammer head, which is of hard quartzite. The mortar is also cut out of a solid piece of quartzite. A man working eight hours will crush from

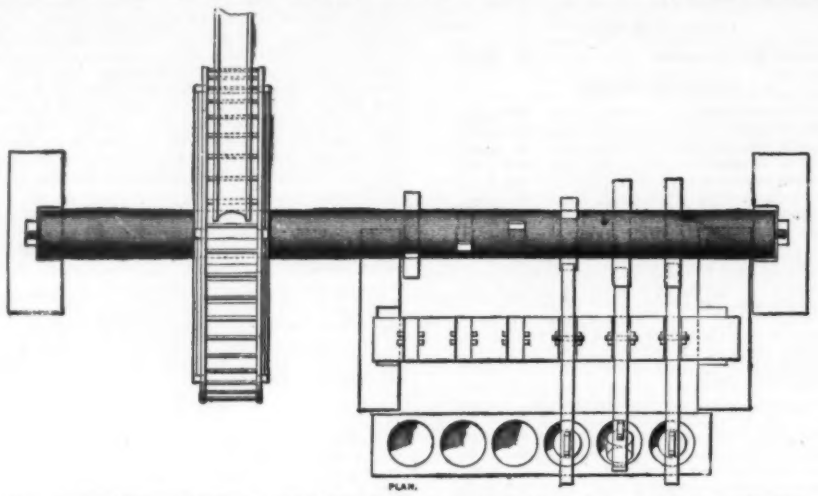


FIG. 2.—WATER POWER QUARTZ CRUSHING MILL, PACHO, NEAR TOMOH.

70 lb. to 100 lb. of stone to a size which will go through a width of mesh equal to 36 to 40 holes per square inch, the sieve being made of strips of rattan one-tenth inch thick. The hammers of the water mill are worked by long, straight cams, if such a term is permissible. The average number of drops for each head is 27 to 32 per minute; the height of drop is 2 ft., and the effective falling weight is 70 lb. The crushing capacity of a six hammer mill varies from 850 to 1,400 lb. per 24 hours, according to the hardness of the rock. On each shift, day and night, two men look after and feed the mill, while a third does the sieving. Another man is usually employed in searching for bowlders suitable for hammer heads. On examining the crushed ore, I found it varied very much in fineness, and that a great deal was crushed far too fine. The size of the hole used at the power hammer is the same as with the foot power hammer, viz., 0·05 in., and fully 80 per cent. will go through 0·024 in. holes, and 40 per cent. will go through 0·008 in holes.

This crushed ore is periodically taken out in wooden pails to another Chinaman, who sits beside a reservoir of running water and works the "dulang." This washing implement is an obtusely conical wooden dish about 2 ft. in diameter, cut from the spurs of hard wood trees. It resembles the South American "batea," though it has straight conical sides instead of curved conical ones. The conical point is carefully rounded off. The dulang is filled with 10 to 15 lb. of crushed ore and is given the usual panning motion, while held just under the surface of the water in the reservoir. The barren pieces of quartz escape over the edge. When nearly cleaned the gold and concentrates are transferred to a smaller, very carefully made and polished dulang about a foot in diameter. The final separation of the quartz is effected here, and the gold is separated from the sulphurets by a skillful jerk. The sulphurets are stored and sometimes, but not always, treated for the recovery of gold. The gold from the dulang is melted over a small forge provided with a box shaped wooden blower of the usual Chinese type. Charcoal is used as fuel, and the crucibles employed contain only about a couple of ounces. The gold dust is melted with borax and niter as fluxes, and the slag is lifted off with an iron rod. The gold is granulated by immersion in water. The principal impurities appear to be sulphur, arsenic, and traces of copper and lead.

During my stay a wash up of 2,000 lb. of crushed ore was made, with what was considered as good results. From this 2,000 lb. there were obtained the following: Rough gold before melting, 3 oz. 11 dwt. 7 gr.; 5½ lb. of sulphurets for retreatment, yielding 16 dwt. gold; 283¾ lb. of sulphurets supposed to be cleaned, yielding 6 dwt. of gold; total gold, 4 oz. 13 dwt. 7 gr. These two parcels of sulphurets gave by fire assay, per ton of 2,240 lb.: No. 1, gold, 273 oz. 9 dwt. 13 gr., and silver 30 oz. 7 dwt. 32 gr.; No. 2, gold, 21 oz. 5 dwt. 8 gr., and silver 2 oz. 1 dwt. 16 gr. The tailings from this washing gave from fire assay, per ton of 2,240 lb.: Gold, 15 dwt. 16 gr., and silver 7 dwt. 12 gr. As a general rule about one-third of the gold is left in the tailings. A rich ore assayed by me gave, per ton of 2,240 lb.: Gold, 6 oz. 12 dwt. 15 gr., and silver 1 oz. 1 dwt. 9 gr. The tailings assayed: Gold, 2 oz. 16 dwt. 10 gr., and silver 5 dwt. 6 gr. The Chinese consider that they obtain one-half of the gold in the ore.

* Abstract of a paper read before the A.I.M.E. See Oct. 1891.—*Eng. and Min. Jour.*

THE PIANO VIOLONCELLO.

THE finest musical instruments, those which, by their resemblance to the human voice, speak most to the soul, are certainly those that are played with the bow (violin, tenor, violoncello, counter-bass). They are superior to the piano, since they permit the artist to prolong the same note and at the same time vary the intensity of it. The excel the harmonium by the quality of their sound, and do not present the inconveniences of wind instruments, such as the flute and clarinet, the diapason of which is scarcely fixed, so that it is impossible to put them in accord with the piano when the latter is not exactly at the normal diapason, which is frequently the case. The violin also possesses an undoubted superiority in forming the voice and for teaching children to sing.

Unfortunately, these instruments are difficult to play, and certain persons, even, are absolutely unable to learn how to do so. In fact, the perception of the accuracy of sounds is an inborn faculty, and practice can only improve it. In the violin and violoncello the accuracy depends upon the position of the fingers of the player's left hand. It is such position that coincides more or less with the mathematical interval desired in order that the string may be brought to the number of vibrations corresponding to a determinate note. Such length, variable for each note, diminishes in measure as the sound becomes sharper. Thus,

THE PIANO VIOLONCELLO AND PIANO TENOR-VIOLIN.

upon the first string the first grave tone from *la* to *si* is measured by a distance of 7 centimeters, while two octaves higher the same tonic interval is realized by a distance of 2 centimeters only. This explains why so many persons play the grave notes correctly and are less happy in the high ones, and why the number of violoncellists is few as compared with pianists. Such are the ideas that have led Mr. De Vlaminck, a distinguished professor of music, to combine the sonorousness and expression of stringed instruments

with the mathematical precision of keyed ones, such as the piano and harmonium.

After many experiments and many tentatives, he has produced and patented an apparatus that is applicable to stringed instruments of the quartet and that permits of replacing the left hand of the artist by a mechanism set in action by the keys of a piano keyboard.

Thus, the piano is played with the left hand and the violin or violoncello with the right. With the bow there may be obtained all the effects of the instrument played naturally (protracted, slurred, detached, short and other sounds, staccati and pizzicati). Through the keyboard the precision is forced, since it is independent of the player and results from a mechanism regulated once for all. The keys are so perfectly connected with the hammers that rest upon the string that it is possible, even, to produce that slight trill called expression.

Mr. De Vlaminck's apparatus permits of making most of the double chords. With practice one may succeed in obtaining the harmonic sounds. There is nothing impossible except the sliding notes (compass of the voice), and the intervals of coma (difference, for example, between *do* sharp and *re* flat). The instrument is consequently tempered like the piano.

Mr. De Vlaminck has studied two types—the piano-violoncello and the piano tenor violin, both of which are shown in the accompanying figure. The first instrument is quite bulky. The keyboard has a range of three octaves, and, by the change of *la* in a string sounding open *re*, the instrument is furnished with a range of five octaves, starting from the grave *do* of the violoncello. The instrument might, therefore, be called also a melotitrophone, since it permits of playing music written for any instrument of the quartet.

The piano tenor violin is smaller and prettier and, we think, will be generally preferred. It may be kept in a box measuring 0·25 m. × 0·28 m. × 0·8 m. It permits of playing music written for tenor violin or violin.

The piano-violoncello and the piano tenor violin are valuable instruments that lend themselves perfectly to music of all kinds. We write this article after playing some sonatas of Beethoven and Haydn and the opening of Suppe's "Porte et Paysan," which contains some pretty quick movements. We believe that Mr. De Vlaminck's invention will be a success. Many young ladies will be glad to be able, thanks to the piano tenor violin, to abandon their piano a little in order to play in duet, almost without a new study, some of the admirable romances without words of Mendelssohn or of the melodies of Schubert, arranged for the violin or piano.—*La Nature.*

DENTON'S METHOD OF CLARIFYING SORGHUM JUICE.*

In clarifying sorghum juice, we added lime to cold juice to alkalinity, added clay paste or wash sufficient to increase the density of the juice about 1° Baumé or 2° Brix, allowed the juice to settle, cold, from one hour to one and one-half hours; decanted the bright and clear liquid, heated it, and added phosphoric acid until litmus paper showed slight acidity; again allowed to settle one hour, and decanted the clarified juice.

By this cold defecation we got rid of the slime and starch, which you have showed to be so troublesome before heating.

By adding lime in excess we secured a good clarification, but colored juice. By heating and adding phosphoric acid we removed all of the lime and restored the color, and also removed some other impurities.

Our sorghum juices are so dense when cold that we are not able to get good settling from cold juice without clay or other weighting material, and I presume your sugar cane juice might subside in less time.

When thus treated, our sorghum juice filters very readily, and the sirup crystallizes to such an extent that it is difficult to make any sirup which will remain sirup.

I had much trouble in finding suitable clay for settling—coarse, granular clays subside quickly, but do not carry down impurities; fine clays require long to settle and leave the juice turbid.

There is, I think, nothing new in this process, but it gives distinctly new results.

I carefully studied your bulletin No. 10 and derived much benefit from it, and have quoted it freely in the report of our work, which will appear in the next department bulletin.

I send you by mail a sample of our sirup made by the above process. I also send you a sample of the clay which we found to work well.

[The sample of sirup sent was beautiful, and excepting a slight acid taste, perceptible to several tasters, was the equal of best cane sirup.—*Ed. La. Planter.*]

* Extract from a letter of Mr. A. A. Denton to Dr. Stubbs.

IMPROVED BRUSH MAKING MACHINE.

BRUSH making is largely carried on by hand, mainly on account of the delicate manipulation required in some of the operations, and also perhaps because no mechanical genius has hitherto been found capable of coping fully with the difficulties involved. An innovation, however, has recently been made in this direction, by the introduction of two very ingenious machines into the brush manufacture by Messrs. G. B. Kent & Sons. These are a machine for gauging knots of bristles for brushes and brooms and a drill for making the holes in tooth brush blanks, and which we recently saw in operation at Messrs. Kent's works at Victoria Park, London. Hitherto the process of bunching the bristles and drawing them into the holes has been performed by hand. The operator forms a loop in the wire which is first passed through the hole in the brush back, and then takes a bunch of bristles, which are placed in the loop, and, pulling the wire, draws the bunch into the hole, these operations being repeated until the brush back is full. The new machine will be found illustrated above, where the operator is seen seated at work, in front of it. In this machine the bristles are contained in a hopper in which they rest horizontally at right angles on the top of a disk, which, by means of a treadle, is caused to partially rotate, first in one direction and then in the other. The disk has a notch formed in its periphery, and as the notch passes under the bristles some of them enter into the notch. Before the disk returns, a plate joined to the disk is moved, and closes the mouth of the notch. The disk then comes back and carries away the tuft of bristle retained in the notch to a position from which it can readily be taken by the fingers of the operative. The whole arrangement is that of a pecker or gripper, and the gripper can be regulated according to the quantity of material required to fill the hole. The operative passes the wire through the hole by means of a special needle fixed to clamp, which she holds in her right hand, the loop being automatically formed. Into this loop she passes the tuft of bristles, pulls the wire, and thus draws the bristles into the hole, repeating the operation at each hole until they are all filled. The work is rapidly performed, and an expert can draw about 1,800 knots or bunches per hour. The saving effected by the use of these machines is stated to be about 40 per cent., the output being about doubled. Although there is this gain to the manufacturer, there is no loss to the operatives, who expressed their satisfaction with the machine.

IMPROVED BRUSH MAKING MACHINE.

The drilling machine to which we have referred is also an ingenious piece of mechanism. It is upon the multiple principle, the head of the brush being completely drilled at one thrust, the drills being carried in a fixed head and making 2,500 revolutions per minute. The drills are arranged in the required form, and the tooth brush blank is fixed in a traversing holder between a pair of centering jaws. The holder advances to the drills, and when the holes have been formed the holder retires, the blank is taken out, and another blank put in its place for drilling. The rate of speed is about five backs per minute, or 300 per hour, which is a remarkable advance on manual labor. Both the machines are the patented inventions of Messrs. Kent & Sons, and are manufactured in the machine shops at their works. Altogether we were very pleased with the machines, which produce work similar in appearance and equal in quality to the best hand work.—*Iron.*

THE ACHIEVEMENTS OF AMERICAN SURGERY.*

By FREDERIC S. DENNIS, M.D., New York.

MR. PRESIDENT AND GENTLEMEN OF THE NEW YORK STATE MEDICAL ASSOCIATION: My first and pleasing duty this evening is to acknowledge with profound respect the distinction which has been conferred upon me by this association. To be selected as the orator of the evening is an honor which the writer most keenly appreciates.

In thinking over something to say upon this anniversary it has occurred to me that no subject could be chosen so peculiarly fitted to this occasion, and so well adapted to this association and to the time in which we live, as a review of the achievements of American surgery. At no time and at no place has this subject ever been fully discussed with these limitations. The advance of surgery in general has been reviewed from time to time in connection with medicine; but an attempt to consider the advance of surgery which is purely American, and to trace its influence upon the nations of the world, is a subject which has never before been attempted.

The debt of gratitude which the world owes to American surgery is great, and though much has been done by other nations older than America, I shall endeavor to demonstrate that American surgery eclipses all other nations of the world in regard to original research, in the introduction of new methods of treatment, in the perfection of older methods, in the inauguration of a complete ambulance system, and, finally, in regard to tangible results. The subject is vast, the study of it is fraught with great interest, and the result of the investigation is most gratifying.

Before considering in detail any of the triumphs of American surgery, it is necessary to bear in mind the important fact that our country is but still in its infancy as compared with other countries, and, therefore, any comparison might appear greatly to the disadvantage of the younger country; but, nevertheless, taking into consideration this most important fact, the writer will endeavor to prove that the achievements of American surgery challenge the admiration of the world.

In these days of Columbian celebration, the rise and progress of the American nation from 1492 down to the present time has been studied and recognized and eulogized. The achievements in every walk of life, the innumerable inventions, the wonderful discoveries, the magnificent results, have all been considered, and the sum total is unparalleled in the history of nations.

In a period of four hundred years great work has been accomplished, and to-day we stand before the gaze of the world as a nation exemplifying the truest type of Christian civilization. While all this progress has been reviewed and considered during the period of the four hundred years, the work of American surgery can only be reviewed during the past one hundred years, since previous to that time American surgery was characterized by no discovery, or distinguished by no invention, or known by any tangible results.

The science of surgery in this country made no impression upon the world until the beginning of the present century, and the mighty works which it has wrought during the present century command respect and esteem from every quarter of the globe. When the nineteenth century had dawned upon us, in the long list of brilliant men who had made the surgery of the world famous, the name of no American appeared upon that honor scroll: but from colonial days down to the present time the names of Americans shine forth in bold relief. What our country has achieved within this period of time is a worthy subject for our study and reflection.

Without doubt, the progress which American surgery has made is due in great part to the dissemination of her medical literature, to the formation of medical libraries, to the organization of hospitals and laboratories, and to the foundation of medical schools. Let us consider for a moment this subject, since its importance demands attention.

The great dissemination of medical literature is made apparent by a reference to Billings' statistics, which show that in the United States, at the beginning of the revolutionary war, there was only one medical book, three reprints, and about twenty pamphlets by American authors, while to-day there are over six thousand medical books, and reprints, and innumerable pamphlets. There are over three hundred and fifty books and pamphlets written and published annually by American writers, to say nothing of over five thou-

* From the *Medical Record*, New York.

sand journal articles contributed each year by our countrymen.

In surgery, there were only three books by American authors prior to 1844, while to-day the surgical writings by American authors fill the shelves of every library upon the face of the earth. It has been demonstrated that in surgery alone, in 1879-80, there were written forty-five surgical books and one thousand seven hundred and seventeen journal articles. This is almost twice as many surgical books as were written in England during the same period and many more journal articles. It can, perhaps, be made even more forcible by stating that, in 1879-80, there were written ten thousand three hundred and thirty-four medical books and journal articles in the United States, while during the same time in England, the other English-speaking nation, there were written only seven thousand four hundred and seventy-six books and pamphlets. In addition to this, many of our medical text books have been translated into other languages and have been adopted as standard text books in foreign medical schools. In 1879-80, there were published more medical journals and transactions in the United States than in Great Britain, France, Germany, Italy, or Spain, and during these two years the total number of original articles in medical journals and transactions exceeded those of any other nation in the world. The wide dissemination of medical literature has been one important factor in the advancement of surgical knowledge in the United States.

At the beginning of the revolutionary war there was one public medical library. It belonged to the Pennsylvania Hospital, and it contained about two hundred and fifty volumes; to-day there are over one hundred thousand medical works in medical libraries in the United States.

At that time there were no hospitals, no laboratories, no training schools for nurses, no medical colleges; to-day hospitals crowd every city and large town, while over a million of dollars have been devoted lately to the establishment of laboratories. There are over a hundred organized training schools for nurses.

At that time there were in the United States about two hundred medical men in practice, who had graduated from foreign schools; to-day there are nearly one hundred thousand medical men distributed throughout the length and breadth of this vast country, and who are graduates of our own medical schools. At that time there were two medical schools in the embryo; to-day there are over one hundred medical schools in the United States. At that time there was one quarterly medical journal; to-day America has the largest proportion of monthly medical journals of all the nations of the world, and nearly twice as many of all kinds as England, the other English-speaking nation. One of the best instances illustrating the progress of American medical journalism is the enterprise of the *Medical Record* in cabling the entire transactions of an International Medical Congress for the benefit of the American medical profession.

At that time there was scarcely a medical society in existence; to-day there are over one hundred recognized and well established State and county medical associations.

At the beginning of the revolutionary war there was not a single medical museum in this country; to-day there are over twenty large well organized medical museums, containing in the aggregate seventy thousand gross specimens, and for the maintenance of which over $70,000 is expended annually, or one dollar a year for the preservation of each specimen. This fact alone is a most convincing proof of the progress which American surgery has made, since the establishment and use of a medical museum is an index of the thoroughness of surgical teaching and practice.

In 1820, Sydney Smith, the great literary genius of his day, made use of the following phrases in the *Edinburgh Review*: "Americans have done absolutely nothing for the sciences . . . In the four quarters of the globe, who reads an American book? . . . What does the world yet owe to American physicians or surgeons? . . . What new substances have their chemists discovered?" I shall take this remarkable passage and transpose it so as to form the different heads of my address this evening, and thus reply to this challenge of Sydney Smith's. It will be my endeavor to demonstrate that American surgery, as a science, has done much to contribute to the welfare of the human race instead of "absolutely nothing." I shall show that many nations of the world "read American books;" and, finally, I shall point out what "new substances their chemists have discovered," and what the world owes to "American physicians and surgeons."

In reviewing the progress of surgery in general there are two things which must not be overlooked, since they have been instrumental in bringing about this great Utopia in surgery. The first is the introduction of anæsthetics, which has eliminated shock, and the second is the introduction of antiseptics, which has eliminated sepsis. The science of surgery has thus eliminated the two great causes of death after surgical operation, viz., shock and sepsis. A new era now dawned upon the profession and the field of operative surgery was vastly widened, the results were made uniformly certain, and new operations were performed which hitherto were considered outside the pale of legitimate surgery. These two beneficent discoveries thus form the two pillars to the triumphal arch. In the pursuit of our subject it is most pertinent at this point to inquire into the influence that this country has exercised in effecting these two great reformations.

1. *The Introduction of Anæsthetics.*—This great event has cast a widespread influence upon the progress of surgery. In 1842 Crawford W. Long, of Georgia, removed a tumor with the patient under the influence of an anæsthetic. No further attempt was made until 1844, when Wells had a tooth extracted while insensible with nitrous oxide gas. Morton, at the suggestion of Dr. Jackson, anæsthetized a patient on October 16, 1846, while Dr. J. C. Warren removed a tumor from the patient's neck. From this time on anæsthesia, hitherto a dream, became a living reality.

This is neither the place nor the time for a discussion as to the merits of the three men whose names are intimately associated with this great discovery. To Jackson, Morton and Wells, in alphabetical order, the profession is indebted for this great boon to suffering humanity. For our purposes to-night the work of each of these men is duly acknowledged. No other nation has succeeded in establishing a claim to this honor. It rightly belongs to us, and the influence of this discovery has had a most important bearing upon the rise and progress of surgery. This discovery has been the great divide toward which and from which all the advances in surgery throughout the civilized world have been accomplished. It is but fair to claim that all the influences emanating and flowing from this discovery should be attributed to it, and since this concession is granted by the world, the progress which surgery has made from decade to decade owes its origin to an American discovery. That it is possible to conceive that anæsthesia might have been born in some other country, if its birthplace had not been here, is readily admitted, but since this great agent for the relief of pain was discovered here, to us properly belongs all the credit which flows from it.

There is one sad event connected with the greatest discovery for suffering humanity, and that is the melancholy termination of the life of each of the three men associated with the discovery. Jackson died insane; Morton died without worldly means; Wells became a pauper, and was arrested in New York City as a criminal for throwing vitriol. He was sent to jail, and there committed suicide by cutting his femoral artery. The tragic termination of life in the case of Jackson, Morton, and Wells, men to whom the world owes a lasting debt of gratitude, is in marked contrast to the beneficent, grand, and glorious work to which their discovery has led. It is interesting to note in this connection that Sir Edward Jenner, the discoverer of vaccination, was awarded $225,000 for his discovery by an act of Parliament, while by no act of the United States government has anything been done to perpetuate the memory of these three men. The physicians of Hartford have erected a statue to Wells, and to them are due the grateful thanks of a nation for their interest in preserving the memory of their fellow townsman.

It is not possible to form an intelligent estimate, or even an adequate conception, of the sum total of human suffering and distress that have been prevented by the introduction of anæsthesia. This American discovery is the greatest contribution to surgery that has been made by any nation in the world. To Sydney Smith's interrogatory, "What new substances have their chemists discovered?" the answer comes thundering down the ages, the greatest discovery of any chemist in the world is the American discovery of a substance to produce anæsthesia.

2. *The Introduction of Antiseptics.*—This wonderful discovery, which has so largely influenced the progress of surgery, belongs to no one nation exclusively. In France, Pasteur made the discovery that putrefaction was due to the presence of micro-organisms. In Scotland, Lister made the application of this science to surgery, and to him is due immortal praise. In Germany and in the United States, the further application and the perfection in the technique was made. The subject of antisepsis, therefore, has been an evolution in which all countries have taken a part, and the complete consummation of which has been participated in by all nations. There are some remarkable facts connected with the early surgery of this country as foreshadowing the introduction of antiseptics. For example, absolute cleanliness was a characteristic feature of Mott's surgery. He was scrupulously careful about washing his hands immediately prior to performing any surgical operation, and every instrument was thoroughly washed just before use. The employment of animal ligatures in this country anticipated their general adoption as an essential part of antiseptic technique of the present day. Dorsey, in 1844, successfully ligatured large blood vessels with buckskin and catgut ligatures, and after him Hartshorne employed ligatures made of parchment. Jameson used ligatures made from deer skin.

The use of the germicide as an antiseptic was wanting; still the American surgeons in early times certainly employed some of the means which to-day include an important part of antiseptic technique.

With this introduction, and also with a reference to the influence of the discovery of anæsthetics and antiseptics upon American surgery, I shall consider, in tracing the progress or the achievements of American surgery, 1st, Surgery of the Bones and Joints; 2d, Surgery of the Vascular System; 3d, Surgery of the Great Cavities of the Body; 4th, Surgery of the Genito-Urinary System; and finally, miscellaneous operations and other topics which cannot be properly classified in the other departments of surgery.

1. *The Surgery of the Bones and Joints.*—The management of fractures has brought out the wonderful mechanical ingenuity which is a characteristic of the American mind. The application of the plaster of Paris bandage in the treatment of fractures is one of the greatest improvements of the century. To the perfection of its technique Fluhrer's work deserves special commendation.

The use of flexible, narrow strips of tin or zinc in the management of fractures was devised by Fluhrer in 1872, with the object of securing immobility of the fractured bones.

The strips are not designed to act as rigid supports, although incidentally by their width (one quarter of an inch) they edgewise oppose resistance to angular motion when passing through or near an axis of motion. Their principal effect is by virtue of their inextensibility; not shortening or lengthening under strain when bandaged to the limb in the principal planes of motion.

They are roughened on each side by perforations, so that they may be securely held in position by the retaining bandage. They are not designed to serve as an accessory strengthening of an immovable splint; the strips themselves are the splint. The plaster of Paris or other material incorporated in the retaining bandages gives to the provisional effect of the strips durability, which, of course, cannot be obtained by a simple bandage.

In the application of the strips, the limb, in simple fractures, is first neatly and evenly covered with some material over which is applied a compressing plaster of Paris bandage. The strips, placed in proper position relative to the planes of motion, are bandaged to the limb as far as the sight of fracture, they, from their flexibility, adapting themselves to the varying contour of the limb. The fragments are then accurately adjusted in position, and as soon as the bandage is carried up the limb, firmly retaining them in relation to the upper fragment, the immobility of the fragments is secured.

In this procedure the adjustment of the fragments in position is accomplished while the outlines of the limb, the principal guide to a correct coaptation of the bones, are unobscured by dressings, and the fragments are immobilized in the shortest time.

In the treatment of fractures of the shaft of the femur special apparatus is necessary in order to properly apply the strips, and for the construction of the pelvic portion of the permanent splint.

The antiseptic treatment of open wounds having practically brought compound fractures into the class of simple fractures, so far as relates to their treatment with permanent apparel, has thereby widened the range of usefulness of the strips by the extension of their applicability to the treatment of these injuries. In compound fractures, the wound having been antiseptically treated, the covering of the limb is made by an even sheet of antiseptic material. The sterilized strips are retained by another layer of this bandage. The fragments having been thus immobilized in correct coaptation while the outlines of the limb are distinct, the antiseptic dressing can then be increased in bulk to meet the necessities of the wound.

The work of Dr. James L. Little in the use of plaster of Paris bandage must not be overlooked, since he utilized this dressing for various fractures, and perfected several dressings for special fractures, notably the patella. This plan has superseded all the clumsy methods in vogue in other countries. Time will not permit of a discussion of the manifold ways that this dressing can be employed in the different fractures. It will suffice to mention the present method of treatment of fractures of the thigh, in order to afford the best illustration of the growth and development of the plan now generally accepted.

If we start with Desault's splint, which was crude and unsatisfactory, the first change that occurred was Physick's modification, which consisted in making Desault's splint, which reached only to the crest of the ilium, to extend above to the axilla and downward below the foot, with a perineal band for extension and counter-extension.

In 1819 Daniell, of Georgia, introduced the weight and pulley. In 1851 Buck still further modified Physick's splint so as to do away with the perineal band, and accomplished extension of the limb by the weight and pulley, after the manner of its present use. This was a great improvement in order to overcome shortening.

Van Ingen, in 1857, suggested the elevation of the foot of the bed to permit the body to act as a counter-extending force. The coaptation splints were now used by Buck, in 1861, so that the present complete and perfect method is one that is the result of evolution, the consummation of which has been accomplished by the work of American surgeons.

In 1827 Nathan R. Smith adopted the principle of suspension in the treatment of fractures, and the use of the sand bag was introduced by Hunt, of Philadelphia, in 1862.

In fracture of the clavicle Sayre has originated a dressing which is not only unique, but which is accepted as the simplest, most reliable, and most satisfactory of all the different forms of apparatus. Moore has also devised a very useful dressing for fracture of the clavicle, consisting of the figure eight (8) bandage.

Physick suggested the two angular splints for treating fracture of the lower end of the humerus, and Gunning and Bean the interdental splint in the treatment of the fracture of the lower jaw.

Dr. Oscar H. Allis first called attention to the pathological condition found in fractures of the lower end of the humerus, and suggested new principles in the treatment to prevent deformities. In 1881, Mason devised a new method of treating fractures of the nasal bones by passing a curved needle under the fragments and elevating them.

In the treatment of fracture of the patella by the use of the metallic suture, American surgery can claim the operation as far as priority is concerned, since Rhea Barton wired a fractured patella in 1834, and McClellan in 1838, and Cooper, of San Francisco, in 1861, and after him, Logan and Gunn.

While American surgery cannot justly claim the priority of this operation as practiced by Lister with the modern aseptic technique, she can at least lay claim to having brought the operation to its present perfected technique, and can point to the fact that here, in New York, the operation has been performed more times than it has been throughout the different countries of the world. In this city the patella has been wired over a hundred times by Phelps, Fluhrer, McBurney, Bull, Dennis, and others, and while the operation is not one to be commended universally, it is an operation yielding brilliant results in suitable cases and in the hands of aseptic surgeons.

The first time that fractures of the lower jaw were treated by the metallic suture was by Kinloch, of South Carolina.

In the management of ununited fractures, American surgery stands pre-eminent. In 1802 Physick passed a seton between the ends of an ununited fracture of the humerus. In 1830, or twenty-eight years after the operation, Physick obtained the specimen.

The use of the metallic suture was first successfully tried in 1827, by J. Kearney Rodgers, in a case of ununited fracture of the humerus.

Perforation of the ends of the bones in an ununited fracture of the tibia was accomplished in 1850, by Detmold.

In 1852 Brainard introduced the operation of drilling the fragments. In 1857 Pancoast used the iron screw to accomplish the same object.

In the management of compound fractures American surgery has achieved remarkable results. The largest collection tabulated in the personal experience of one surgeon is the list by the writer of one thousand cases of compound fractures, with a mortality from septopyæmia of one-seventh of one per cent. The best published reports from Europe are from Billroth, whose mortality in compound fractures was three per cent.

No better idea of the onward march and steady progress of American surgery can be formed than by a consideration of the fact that before the days of antiseptic surgery the death rate has been as high as sixty-eight per cent. in the major fractures, and now that mortality has been practically reduced to zero.

The ingenuity of American surgeons cannot be better illustrated than by demonstrating to this audience a splint made by Dr. Cotting, of Roxbury, Mass. Dr. Cotting is a retired surgeon, who is now over eighty years old, but who has kindly furnished me some interesting facts in regard to the manufacture and use of splints for fractures. Dr. Cotting amused himself, one day recently, in making this splint, such as was in vogue years ago in New England. This splint is a model of Yankee ingenuity, and one perfectly adapted to the treatment of fractures.

Besides the perfect adaptability of the splint, it has the essential characteristic, that is, it is simple and can be made by any one, at any time, and in any place. The perfect simplicity becomes apparent when it is considered that this splint itself was made from a fragment of a piece of a millinery box, the iron from a tub hoop, the rivets from ordinary tacks, the cloth and wadding from remnants in the house, and the paste made from flour and water. All of these requisites can be found in any house in a city, or in a log cabin in a remote wilderness.

The application of the iron to the splint was effected by using as an anvil the head of a hatchet struck into a block, and a common house claw hammer to rivet the tacks, the holes for which were driven by a sharp-pointed nail. Dr. Ira Allen, of Roxbury, Mass., about half a century ago suggested the use of iron in the construction of splints, and Dr. Cotting at that time made splints such as the one now on exhibition. This splint has lightness, strength, and simplicity, and possesses at the same time every advantage that can be possibly claimed for any splint. This splint affords comfort to the patient, and is capable of adjustment to any fracture or to any diseased joint. The true germ of every useful splint of the present day is found contained in this model.

In 1878 Pilcher first pointed out the correct pathology and treatment of fractures of the lower end of the radius.

Before dismissing the subject of fractures, the work of Frank H. Hamilton must not be overlooked, since he did more to systematize and to perfect the treatment of fractures in general than any other American surgeon. The work of Stimson likewise deserves the highest tribute of respect. The saw devised by Shrady for performing a subcutaneous section of the bone is an instrument worthy of the highest commendation. Excision of the superior maxillary bone, with the exception of the orbital plate, was first performed by Jameson in 1820.

The complete excision of the superior maxilla was first performed in this city by David L. Rodgers in 1824. Excision of the inferior maxilla was first partially and successfully made, "without known precedent or professional counsel or aid," by Deadrich, of Tennessee, in 1810. Jameson exsected nearly the entire inferior maxilla in 1820, Mott exsected one-half of the jaw in 1821, Ackley in 1850, and Carnochan excised the entire bone in 1851. Excision of the os hyoides was performed for the first time, by Dr. John C. Warren, in 1803. Excision of the wedge-shaped piece of bone from the tibia and fibula, with osteoclasis of the bones to correct a deformity by an osteotomy, was performed by Dr. John C. Warren in 1820. In 1835 Barton devised an operation which is still practiced for the relief of angular anchylosis of the knee. The entire clavicle was excised successfully for necrosis for the first time, in 1813, by McCreary, of Kentucky. The entire clavicle was again excised successfully for the first time, for malignant disease, by Mott, in 1828. The entire scapula, three-fourths of the clavicle, and the arm were excised for the first time, and also successfully, by Dixi Crosby, in 1836. This same operation was repeated by Twitchell in 1838, by MacClellan in 1838, and by Mussey in 1845, and since then to the present time the operation has been performed about twenty-five times throughout the world.

The entire scapula and the clavicle were removed successfully, six years after an amputation at the shoulder joint, by Mussey, in 1837.

Two-thirds of the ulna was excised successfully by Butt, of Virginia, 1825, and the olecranon by Buck, in 1842, while the entire ulna was excised by Carnochan, in 1853. The same operator excised the entire radius in 1854. Both radius and ulna were excised by Compton, of New Orleans, in 1853.

Excision of the coccyx was first performed by Nott, in 1832, for the relief of severe and persistent neuralgia.

Excision of a portion of the rib by the trephine, for affording drainage in empyema, was first performed by Stone in 1862, and excision of a part of one or more ribs for the same purpose was first performed by Walter, of Pittsburg, in 1857.

Removal of a disk of bone for drainage in non-traumatic, diffuse, acute, suppurative osteomyelitis, was done in 1798 by Nathan R. Smith, who anticipated Brodie in the performance of this operation. Brodie's operation had reference to circumscribed abscess of bone.

Besides these excisions for necrosis, suppuration, and malignant disease, much credit is due to American surgery for the part it has played in subperiosteal surgery. One of the most remarkable specimens is the reproduction of the inferior maxilla by Wood, in 1856. This jaw was exhibited by Dr. Wiggin, at the Berlin Congress of Surgeons, in 1877, and Langenbeck, the authority on subperiosteal surgery, said that "he did not believe a corresponding preparation really existed anywhere," and remarked that "there was not another such specimen in the whole of Europe." This was indeed a fitting tribute from one of Europe's greatest surgeons to the genius of one of America's greatest operators.

Wood has also succeeded in reproducing many other bones in the body by the application of the same principles of subperiosteal surgery. These specimems form an unique group, and are carefully preserved in the museum which bears his name. Thus it is evident, if the first successful excision of the superior and inferior maxillæ, the hyoid bone, the entire clavicle, the entire scapula, the ulna and radius, the coccyx and ribs; also trephining for relief of osteomyelitis: the most perfect specimens of reproduced bone, be subtracted from the sum total of operative surgery upon the bones, there is little left that is not the offspring of American surgery.

In the surgery of the joints, American surgeons have accomplished brilliant work since. In the management of dislocations they have contributed much to the sum total of our knowledge. Physick was the first to perform venesection to cause muscular relaxation, in order to reduce a dislocation. This was a most valuable means, to which resort was made prior to the introduction of anæsthetics.

In 1856 Dugas pointed out a most important diagnostic sign, of great value in dislocation of the shoulder. Bigelow pointed out two obstacles to reduction in hip joint dislocation.

In 1826 Dixi Crosby demonstrated the causes of failure to reduce the dislocation of the thumb, and showed that forced extension and pressure upon the base of the dislocated bone would effect a reduction.

In 1855 W. W. Reid published his method of reducing dislocation of the hip by manipulation, to which must be added the contributions of Smith, Gunn, Bigelow, and Stimson.

McKenzie and Smith, in 1805, reduced a dislocation of the shoulder of six months' standing by the employment of venesection. This patient had been to England and all attempts at reduction failed, and upon his return to Baltimore the reduction was effected by relaxing the muscular system by blood letting *ad deliquium animi*. This plan is now abandoned since the introduction of anæsthetics.

John C. Warren excised the head of the humerus to restore the usefulness of it after an unreduced dislocation of the shoulder joint.

Wood practiced tenotomy with great success in order to reduce difficult dislocations of the major joints, and also for dislocation of the perineal tendon.

Before dismissing the subject of tenotomy, it is stated in Cooper's "Dictionary of Surgery," that Gibson, in 1842, divided the straight muscles of the eye for the relief of strabismus, several years before Dieffenbach, of Berlin.

Sayre is the American surgeon who is entitled to the honor of having established orthopedic surgery as a separate school of surgery in this country.

In the inflammatory affections of joints American surgeons have advanced the principles which to-day are considered sound, and which are universally adopted.

Physick insisted upon absolute rest of an inflamed limb. Harris, in 1825, first insisted upon fixation and extension in the management of inflamed joints. Later on the principle of fixation and extension was modified, so as to permit the patient to be up and about; subsequently this principle was carried out in the ankle and knee joints by an instrument devised by Sayre, and in the hip by an instrument first invented by Davis, of this city, previous to 1860, and since modified and improved by Sayre.

There are other splints which are employed that are most useful, notably those of Taylor, Schaffer, Ridlon, A. M. Phelps, Gibney, and others, while the work of Whitman, Willard, Judson, Vance, Reginald Sayre, and Townsend in this department of surgery merits the highest consideration.

The invention of the plaster of Paris jacket by Sayre, for the treatment of Pott's disease, in 1874, is one of the most important surgical discoveries of the century.

These cases of Pott's disease, which hitherto were consigned to a distressing death, are now permanently relieved of their sufferings, and are in many cases entirely cured.

Excision of the hip joint was performed as a systematic operation, and successfully, for the first time in this country by Sayre, in 1854. To this same surgeon is due the credit of suggesting and carrying into execution the principle of free drainage in cases of empyema of joints.

In hydrops articuli, Martin, of Boston, in 1853, suggested equable uniform compression by means of an elastic bandage, and Sayre has applied the same principle by using compressed sponges. Martin, in 1877, also employed the elastic bandage for the cure of chronic ulcers of the leg.

In 1826 Barton divided with a saw the great trochanter and the neck of the thigh, to relieve anchylosis of the hip joint; in 1830 Rodgers removed a disk of bone, and in 1862 Sayre perfected the operation and introduced a new principle by removing a plano-convex wedge of bone between the two trochanters, and made a round the end of the lower fragment in order to form a new and artificial joint.

In 1835 Barton removed a cuneiform wedge just above the condyle, and fractured the bone, and made the limb straight to relieve angular anchylosis of the knee joint. This operation is practically the osteotomy of the present time.

In 1840 Carnochan first operated for the relief of anchylosis of the lower jaw by subcutaneously dividing the masseter muscle. In forcing open the mouth after tenotomy of the muscle, he accidentally fractured the bone, thus producing a false joint until the fracture united. Carnochan conceived then the idea of excising a wedge-shaped piece from the jaw and establishing a false joint.

For the relief of this distressing condition, in 1873, Gross excised the condyle and a portion of the neck of the bone, and in 1875 Mears excised the coronoid and condyloid processes together with the upper half of the ramus.

Wood, in 1876, cured a patient with fracture of the cervical vertebra associated with paraplegia and brachial paralysis, by the use of the plaster of Paris jacket. The patient, though completely paralyzed, made an excellent recovery and was able to resume his work as a carpenter.

2. *Surgery of the Vascular System.*—In the surgery of the vascular system American operators have made most valuable contributions.

The innominate artery was ligated for the first time in the history of surgery by Valentine Mott, of this city, on May 11, 1818. The operation was performed for the cure of aneurism, and the patient died. The operation was essayed for the second time by Hall, of Baltimore, in 1830; and again by Cooper, of San Francisco, in 1859. Both of these cases terminated fatally. The artery was finally tied successfully for the first time by Smyth, of New Orleans, on May 9, 1864. This last operator tied also the vertebral in the same patient for the first time. Thus it is evident that the ligature of the innominate artery was first performed in this country, and it was first ligated successfully in America. And the artery has never been ligated anywhere else successfully but in this country.

Mott tied 138 large arteries for the relief of aneurism, and no surgeon in the world ever has ligated so many vessels.

The primitive carotid artery was ligated for the first time successfully, for primary hemorrhage, by Cogswell, of Hartford, Ct., on November 4, 1803. Abernethy is accredited with tying the primitive carotid first in 1798; but his case died. The first successful case, therefore, of ligature of the primitive carotid for primary hemorrhage was in America, and Cogswell had no knowledge of Abernethy's unsuccessful attempt.

Again, the primitive carotid was first tied successfully for secondary hemorrhage by Amos Twitchell, of Keene, N. H., in 1807, eight months prior to Sir Astley Cooper's famous case, which was supposed until lately to be the first upon record.

The primitive carotid was first tied in its continuity successfully, for the cure of aneurism, by J. Wright Post, on January 9, 1813. This same surgeon again repeated the operation successfully on November 28, 1816.

The two primitive carotids were first tied in their continuity successfully, within a month's interval, by Macgill, of Maryland, in 1823. Mott tied both carotids simultaneously in 1833, for malignant disease of the parotid gland. In 1823 Davidge first tied the carotid artery for fungus tumor of the antrum. The primitive and internal carotids were first tied simultaneously by Gordon Buck, of New York City, in 1857, and again by Briggs, of Nashville, in 1871. The internal carotid was tied successfully above and below, for secondary hemorrage, by Sands, in 1874. Carnochan tied both carotids for the first time, for elephantiasis arabum of the neck and face, in 1867.

The subclavian artery in its third portion was first tied successfully, for the cure of aneurism, by J. Wright Post, of New York City, in September, 1817. The subclavian artery in its first portion was ligated for the first time by J. Kearney Rodgers, in 1845. The case died, and the vessel has never been tied successfully until 1892, when it was tied by Halsted, of Baltimore. The operation was for the cure of aneurism, and the sac was dissected out by removal of the clavicle. This is the only case in which the ligation of the subclavian on its tracheal side has ever been successful, although it has been attempted in other countries; but the vessel has never been tied successfully except in this country.

The primitive iliac artery was first tied in America by Gibson, of Baltimore, in 1812. The ligation was for the arrest of hemorrhage following a gunshot wound. The patient died on the thirteenth day. Valentine Mott tied the artery successfully, for the cure of aneurism, on March 15, 1827. In 1880 Sands first tied the primitive iliac for aneurism of the left external iliac, by performing first a laparotomy and securing the vessel by this procedure.

The internal iliac was first successfully tied for the cure of an aneurism, by Stevens, in 1812, and again successfully by Mott, in 1827, and by White, in 1847.

The two internal iliacs were first tied simultaneously, for the cure of double gluteal aneurism, by the writer, in 1886. In this case a laparotomy was first performed. The patient died of uræmia. The same operator has since tied successfully the internal iliac for the cure of gluteal aneurism, for the first time, by laparotomy, as a first step in the operation; and also the internal pudic branch of the internal iliac artery, for the first time successfully outside the pelvis, for the arrest of secondary hemorrhage in the perineum.

The external iliac was tied successfully in 1811 by Dorsey, and again successfully by Post in 1814.

In 1794–95 Post placed a ligature around the femoral artery for the cure of aneurism, and the patient was cured. Onderdonk, in 1813, tied the femoral artery successfully for acute phlegmonous inflammation of the knee joint, and Rodgers did the same operation with success in 1824.

Carnochan, in 1851, tied the femoral artery for the first time for the cure of elephantiasis arabum, thereby inaugurating a new principle of treatment.

In May, 1821, Jameson ligated the external iliac artery, and Davidge, who settled in Baltimore in 1796, shortly after this first ligated the gluteal artery.

Thus it has been shown that the ligation of the innominate, the subclavian, both in the first and third portion, the primitive carotid, both primitive carotids simultaneously, primitive and the internal carotids, the primitive iliac and the internal iliac, have all been tied for the first time successfully in America; and further, that the primitive carotid was first successfully tied for primary hemorrhage, and also for secondary hemorrhage, and the primitive and internal carotids simultaneously tied for traumatic aneurism, and the internal carotid for secondary hemorrhage, and both internal iliacs simultaneously in this country.

In the surgery of the arteries there seems little left to the credit of any other country.

In addition to the various ligations already mentioned for the cure of aneurism, the invention of a variety of compression known as digital pressure was carried into practice by Jonathan Knight, of New Haven, in 1848.

There are many modifications of digital pressure. Wood utilized the bag of shot, which was suspended above the patient, and by this means the pressure was effected by it instead of by the finger.

In 1874 Stone, of New Orleans, first cured a traumatic aneurism of the second portion of the subclavian artery by digital pressure upon the third portion of the vessel. Martin, in 1877, suggested the use of the elastic bandage in the treatment of varicose veins, and Dr. Charles Phelps the method by the multiple ligature of the veins from the ankle to the saphenous opening. He applies some thirty ligatures to the limb, and the results of his operation have been most satisfactory.

There has been much diversity of opinion as to whom the credit belongs for the introduction of the Esmarch bandage. In the public clinics of the Jefferson Medical College, at the time of an amputation, the limb was rendered bloodless by elevation of it, and by the application of a roller bandage to it by the elder Pancoast and Gross. This was done before a tourniquet was applied. The value of this procedure was not pub-

lished, and to Esmarch is due the credit of having adopted the principle with the modification of the elastic bandage, and having published it abroad for the benefit of the profession.

In 1874 Woodbury, of Philadelphia, suggested digital pressure of the common iliac with the hand introduced through the sphincter. And Wyeth has devised a method of controlling hemorrhage during amputation of the hip joint, which deserves worthy mention.

3. *Surgery of the Great Cavities of the Body—Surgery of the Cranial Cavity.* — In cerebral surgery American surgeons have accomplished excellent work. This is not the place or the time to review the entire field of brain surgery. Within a few years great progress has been made in this department; but that part which has reference to the work of American surgeons only concerns us this evening.

Trephining for the relief of epilepsy was performed by Dudley, of Kentucky, prior to 1828, with 60 per cent. of permanent cures. Dr. Mason Warren trephined a child for epilepsy in June, 1849, for the relief of accidental idiotism. A case of cerebral abscess was opened by Detmold in 1855, in which case the operator gave vent to pus contained within the lateral ventricle. The lateral ventricle itself was opened by Dennis, in 1889, with a view to remove a blood clot in a case of traumatic hemorrhage. There was no wound of the soft parts or fracture of the bone to indicate the place to trephine, and the diagnosis of cortical hemorrhage was made before the operation. This is a unique case in the annals of surgery.

The brain substance itself has been explored by Fluhrer, who was the first to locate a pistol ball within the brain by the use of his special probe. He extracted the bullet by counter opening made by a trephine. He had also extracted a bullet which was embedded in the substance of the brain 2¾ in., which he located by the probe, and the operation was followed by complete recovery.

In the removal of cerebral tumors, American surgeons cannot establish any claim for priority, and but little for originality; but they can at least establish claim for having had many cases of this nature, since nearly one-third of all the cases operated upon have been by American surgeons. The work of Weir, Keen, Roswell Park, Mills, Hearn, McBurney, Birdsall, Bullard, and Bradford, Markoe, Curtis, Charles Phelps, Deaven, Bryant, Lloyd, and Hun deserves the highest commendation. American surgery would be ungracious not to acknowledge the work of Starr, Mills, Seguin, Putnam, Spitzka, Gray, McDonald, Sachs, Dana, Janeway and Clymer, since these neurologists have prepared the way for the work of the surgeons. Trephining for traumatic meningeal hemorrhage, for pachymeningitis interna hæmorrhagica, and other like conditions, have been employed by surgeons who have reported the result of their operations.

In all probability the most important medical event that has ever happened in this country and the world was the conception, development, and birth of ovariotomy. To Dr. Ephraim McDowell, of Danville, Ky., belongs this great honor. In 1809 he was the first to perform this unique and original operation which has made his name immortal. The far-reaching influences that have proceeded from this step are incalculable. Dr. McDowell is finally recognized as the originator of not only one of the greatest operations in surgery, but also as the author of an operation the influence of which has made it possible to develop the present wide field of abdominal surgery. McDowell's work will live in the memory of thousands in this land, and will be honored the world over as long as time endures.

(To be continued.)

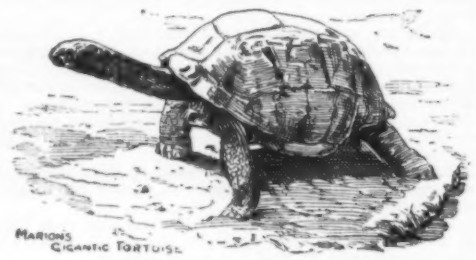
GIGANTIC TORTOISES.

FOR many years Dr. Albert Gunther, of the British Museum, informs us naturalists were much exercised in curiosity by the shells of tortoises of enormous size that were brought home in vessels coming from India. "From the greater convexity of their shell, these animals were known to be terrestrial and distinct from the marine turtles. From the accounts of voyagers of the sixteenth and seventeenth centuries it was found that these huge individuals of the Chelonian order existed in two widely separated regions, one being the Galapagos group in the Pacific, the others being certain islands in the Indian Ocean; yet, curiously enough, it does not appear that the intervening lands have contained within the historic period similar creatures. Leguat mentions the immense numbers of land tortoises he and his companions found in Rodriguez; and, indeed, when we consider that the helpless creatures lived for ages in perfect security from all enemies, and that nature had endowed them with a most extraordinary degree of longevity, so that the individuals of many generations lived simultaneously in their island home, we can well account for the multitudes found by the first comers. For a period of more than a century they afforded wholesome food to the crews of passing ships; for these animals could be carried in the hold of a ship without food for many months, and could be slaughtered as occasion required, each tortoise yielding from eighty to 300 pounds of fresh meat, and we read that ships leaving Mauritius were wont to take on board upward of 400 of these animals."

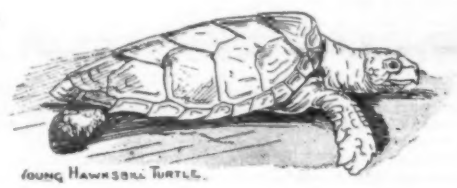
THE DECLINE AND FALL OF THE RACE.

They appear to have been much more scattered in the larger islands of Mauritius and Réunion than in the smaller island of Rodriguez, for in 1761 Admiral Kempenfeldt writes: "The best production of the island is the land turtle, which is in great abundance. Small vessels are continually employed in transporting them by thousands to the isle of Mauritius for the service of the hospital. Their number, Dr. Gunther goes on to tell us, rapidly diminished, owing to their consumption as above evidenced, as well as by the widespread and frequent conflagrations of the woods, by which the island has been well nigh disforested, so that early in the present century the work of extermination was accomplished, and, so far as is known, there is not a single living example left at the present day. In the small island of Aldabra alone there still linger, in a wild state, a few representatives of this ancient Chelonian race, the contemporaries of the Dodo, the Géant and the Solitaire. Even here the animals are constantly destroyed by the whalers, and the young tortoises and eggs are eaten up by the pigs which have been left there, and which have multiplied rapidly."

A large example of what was, in Dr. Gunther's opinion, one of the last of the Rodriguez species was imported more than half a century ago to England, and kept at the Zoological Gardens, where it was living when described in the Proceedings of the Society in 1833. It weighed 289 lb., the shell being 4 ft. 4¼ in. in length (over the curve) and 4 ft. 9 in. in width. This was one of two tortoises which were imported by Capt. Marion, the celebrated navigator, into the Isle of France in 1766, and brought to England by Sir Charles Colville. When Mauritius was surrendered to Gen. Abercrombie in 1810, among the ordnance stores handed over to and taken in charge by the Royal Artillery



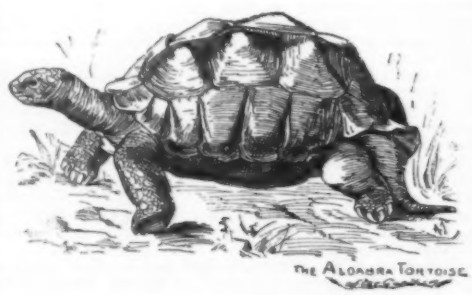
were these two huge land tortoises, which, if they are Rodriguez animals, must certainly have been living in the days of Leguat. The survivor is still alive, and has been a denizen of Artillery Place and the barracks in Port Louis ever since, having survived many accidents and cruel experiments. Its shell is 9 ft. 3 in. in circumference, and it stands 2 ft. 6 in. high. Measures have been taken to preserve the tortoises in Aldabra, and some of these Chelonians have been introduced into Flat Island, near Mauritius, by the Mauritius Acclimatization Society, and are, it is said, thriving, if not multiplying. They lay their eggs three times in the year. In the Botanical Gardens of Pamplemousses, in Mauritius, are two tortoises, of which one, measuring 7 ft. 2 in. in circumference, stands 1 ft. 8 in. in height; and there are others at Rivière Seche belonging to M. Castel, and another to M. Daruty, at Mon Trésor, near Mahébourg, in Mauritius. There are others in the Seychelles Islands, whence two fine specimens have been brought to the Zoological Gardens; and there were for a long time till lately (dating from before the days of Napoleon) two fine specimens in the grounds of Plantation House at St. Helena, where one died in 1877. The osseous remains of the Rodriguez tortoises, which Dr. Gunther has examined, and for



which he was indebted to M. Bouton and the trustees of the Glasgow Museum, were found to include some exceedingly large bones, larger than any of those from Mauritius, and they must have belonged, he states, to individuals of the size of the large living males of Aldabra.

A PECULIAR HABIT OF THE RACE.

From the perforation of the neural arch of the sixth nuchal vertebra Dr. Gunther determines that these animals had the habit of bringing the neck in a vertical position, so that these two vertebræ were standing nearly at a right angle. Leguat writes: "There's one thing very odd among them; they always place sentinels at some distance from their troop, at the four corners of their camp, to which the sentinels turn their backs, and look with the eyes as if they were on the watch." This habit of raising their necks nearly perpendicularly must have greatly aided the capability of seeing to some distance around them which these animals seem to have possessed. Dr. Gunther assumes that "some land tortoises were carried by stream or current from Madagascar or Africa to the Mascarene Islands, in preference to assuming a former continuity of land between the Mascarene Archi-



pelago and Africa; but the direction of the great equatorial current and prevailing southeast trade wind militate considerably against the theory. With this hypothesis" (of submergence of land between the Mascarene Islands), writes Dr. Gunther, "we should be obliged to contend for this animal type an age extending over enormous periods of time, of which the period required for the loss of power of flight in the Dodo or Solitaire is but a fraction." Of the remains from Rodriguez, the species *Testudo Vosmæri* can alone be distinguished; of this reptile an extensive series is preserved in the Cambridge Museum, from Newton's find. —*Daily Graphic.*

EXPLORATION OF THE UPPER REGIONS OF THE ATMOSPHERE.

MUCH has been recently said of a project of Mr. Capazza, which consists in sending to as great a height as possible a small balloon provided with registering apparatus designed to explore the upper regions of the atmosphere and to bring us back meteorological data of the highest interest.

The communication made by Mr. Capazza to the Academy of Sciences has had the immediate effect of hastening the publication of a similar project which has been well elaborated, and prepared for a long time already by Commandant Renard, director of the establishment of military aerostation of Chalais-Meudon. It was not for the purpose of claiming the priority of

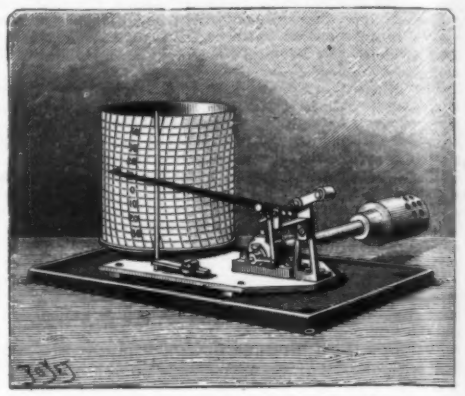


FIG. 1.—LIGHT THERMOGRAPH DESIGNED TO MEASURE THE TEMPERATURE OF THE HIGHER REGIONS OF THE ATMOSPHERE.

this idea that the eminent engineer communicated the details of his project to the Academy of Sciences and the French Society of Physics. This very natural idea must have occurred to all meteorologists and many aeronauts. With Commandant Renard it was a question of setting forth the difficulties of the problem and to make competent men share in the hope given by calculations based upon a profound knowledge of the subject. At first sight, it does not seem to appear much more difficult to send a balloon to a height 20 kilometers than to 15, or to 25 than to 20. In reality, the lowest of these limits is easy to reach, the second is difficult, and the third is *quasi*-impossible except at an enormous expense.

The advantages of an unmounted balloon are considerable. In the first place, several ascensions, of which the last was the heroic and unfortunate expedition of the Zenith and of which Mr. Gaston Tissandier remained the sole survivor, have shown that man cannot, without danger, go beyond 8,000 or 8,500 meters, and that starting from 7,500, the conditions of the temperature and rarefaction of the air are so bad that the observations must necessarily feel the effects thereof. Such inconveniences do not exist for registering instruments; and, since it is a question not only of a difficulty to be once conquered, but of a system of regular observations to be created, the pecuniary question intervenes and imposes on the dead weight of the whole a limit that budgets do not permit of exceeding. It must be remarked, too, that when one exposes human life it should be done with the least risk possible, and that for the balloon, one should adopt a very high coefficient of security. If it is a question of but a few apparatus, one can, on the contrary, keep very near the limit, and not fear even to risk his instruments a little if, in exchange, he can in the exploration gain a few kilometers in height.

The general principles of the problem being thus laid down, the following is the special programme that Commandant Renard had traced: To send to a height of 20 kilometers a collection of apparatus, such as the thermograph, barograph, and actinograph, as well as instruments designed for registering electric phe-

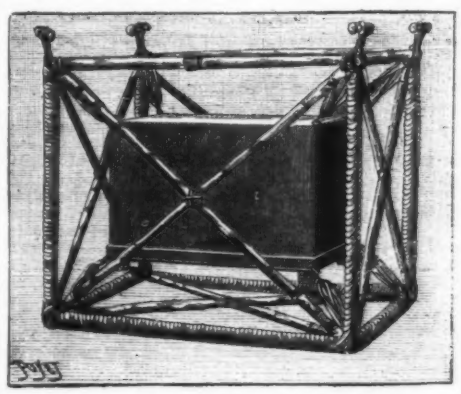


FIG. 2.—ARRANGEMENT OF THE BAROGRAPH IN ITS PARACHOC.

nomena or for bringing back air collected in these high regions. These instruments, moreover, may be carried away in succession, the barograph naturally making part of each expedition.

With the two first registering apparatus there were no great difficulties, for Mr. Richard had conquered them all in advance in his ingenious instruments. It sufficed to lighten them, and we shall see that the skillful constructor has acquitted himself of this marvelously. The actinograph is more delicate, yet, thanks to the interest that Mr. J. Violle has taken in

the project from the start, the apparatus is now all right, and it may be hoped that the data of these new researches will complete those that the eminent physicist has gone to collect upon the highest summit of Europe. Mr. Leduc, who has devoted himself to researches upon the composition of the air, has prepared some balloons that will open automatically and immediately close.

Commandant Renard having a long time ago done me the honor to disclose his projects, I have thought that it would be possible to examine the law of the variation of pressure by means of a bathometer—an instrument serving to measure gravity; but up to the present no form of this apparatus has appeared that is perfectly satisfactory, being given especially the limit of weight imposed by the construction of the balloon. This examination of the law of Laplace is not useless, since, as Mr. Mascart has recently shown, observation does not accord with the logarithmic formula at great altitudes.

But it is time to touch upon the practical study of the question.

It was desirable not to much exceed 100 cubic meters for the capacity of the balloon, in order to reduce the cost of inflation to a minimum, and to increase, at equal expense, the number of the excursions. The ascensional force of common hydrogen being, under ordinary conditions, 1·122 kilogrammes per cubic meter at the start, the weight that the balloon is capable of supporting in regions where the pressure is reduced to a tenth is only 11·22 kilogrammes, inclusive of that of an impermeable envelope of 104 square meters. The limit imposed for the weight of the latter was 50 grammes per square meter. It was to be, moreover, strong enough to withstand a pressure of from 30 to 35 millimeters of water, with a diameter of about 6 meters. The instruments as a whole, with their "parachoc" and the netting, were not to greatly exceed 5 kilogrammes.

This is the way in which these various conditions have been fulfilled: The envelope is made of Japanese paper, rendered impermeable by a special varnish, and reaching just the limit imposed. The cost of the balloon is 150 francs, and it can be repaired indefinitely.

The barograph and the thermograph, which weighed at first 2·8 kilogrammes, have been reduced to less than 1·2 kilogrammes each by the judicious use of aluminum and a rational lightening of all the parts. As for the "parachocs," designed to prevent the appa-

FIG. 3.—FREE BALLOON WITH ITS REGISTERING INSTRUMENTS.

T. Thermometer. B. Barometer.

ratus from being damaged on landing, they are formed of a cage of osier and bamboo, properly crossbraced, and in which the instrument is suspended by rubber bands fixed to the eight angles of the box. Fig. 1 represents the well-known thermograph of Mr. Richard. The spiral designed for taking the temperature of the air is inclosed in a perforated cylinder that may be seen in the rear of the figure. It contains alcohol in an internal cavity 0·2 millimeter in thickness. It is entirely protected from the radiation of the sun by an open-work parasol.

In Fig. 2 may be seen the barograph in its cage. The protection is so efficacious that in the course of his communication to the Society of Physics Commandant Renard was able to throw the instrument violently to the floor in all directions without the clockwork ceasing to run. Except in a squall of wind, the balloon, acting as a parachute, ought not to have, upon landing, a total velocity of more than 6 meters per second, and the shocks will remain less than those that the instruments have already undergone.

Fig. 3 shows the project as a whole such as it has been decided upon for the first ascensions. Here, moreover, are the exact numerical data:

Diameter of the balloon	6	meters
Capacity " "	113	cubic meters
Surface " "	113	" "
Weight of envelope	5·650	kilogrammes
" " netting	0·573	"
" " registering apparatus	2·3	"
" " parachocs	1·0	"
Total,	9·523	"

Various accessories will carry this weight to 10 kilogrammes. Under such conditions, the balloon will ascend until the ascensional force is reduced to $\frac{10}{113} = 0{\cdot}0885$ kilogramme per cubic meter, and the pressure, consequently, to $\frac{0{\cdot}0885}{1{\cdot}122} = 0{\cdot}079$ kilogramme, that is to say, in a region where the barometer is at 58 millimeters.

The altitude obtained would be in the neighborhood of 20 kilometers. Two operating methods may be employed. In fine weather, the best will be to fill the balloon only partially. It will become inflated in measure as the pressure diminishes. In foul weather, the difficulty will consist in getting beyond the clouds. It will then be necessary to have recourse to the method devised at Metz in 1870 by Colonel Goulier. The balloon, entirely filled, will be ballasted by a silk bag full of water mixed with alcohol, which will flow out slowly, continually elevating the zone of equilibrium of the balloon.

In both cases, a slight leakage will shorten the stay at the maximum altitude, and it is estimated that the total duration of the expedition will be about six hours.

The cost of an experiment may be estimated at about 50 francs in fine weather and 150 in foul, supposing that there is no serious damage.

The main point of the project that we have just examined consists in the adoption of a light envelope. A very simple calculation shows, in fact, that, all things otherwise equal, the volume of the balloon designed to ascend without any supercharge to a given height increases as the cube of the weight of the square meter of the envelope. Such weight is 300 grammes in ordinary envelopes, and, taking into account the weight of the instruments, which is considerable with respect to little balloons and of small account for a large balloon, we reach for the latter, under ordinary conditions, the figure of 4,200 cubic meters. The experiment might be tried, but it would be costly.

Let us repeat that the whole value of the project under consideration lies not in the first idea, but in the profound study of the question that has led to a very economical solution. It only remains for us to wish the balloonist a good voyage and safe return.—*C. E. Guillaume, in La Nature.*

THE MONT BLANC OBSERVATORY.*

THE project of establishing a meteorological and astronomical observatory on the summit of Mont Blanc, under the care of M. J. Janssen, of the Meudon

Observatory, made considerable progress during last year's summer months. It has been decided to use the snow itself as a foundation on which to rest the building. That this can be done with security was shown by some experiments carried out at Meudon last winter. A miniature mountain was made of snow pressed to the same density as that which is found on Mont Blanc at a depth of one or two meters below the surface. This being made level at the top, disks of lead 35 cm. in diameter, and weighing each about 30 kgr., were placed on the snow, one upon the other. After twelve of these had been piled up, with an aggregate weight of 360 kgr., they were removed and the depth of the impression measured. It was not more than 7 or 8 mm. Thus a structure measuring 10 m. by 5 m. might safely weigh 187,000 kgr. without sinking into the snow more than a few centimeters.

The summit of Mont Blanc is formed by a very narrow edge of rock 100 m. long, running from west to east, and covered by snow which is thicker on the French than on the Italian side. The level of this snow has not shown any important oscillations throughout a number of years. To obviate the disturbing effects of the storms which frequently rage round the summit, the building is constructed in the shape of a truncated pyramid, the lower floor being sunk into the snow. The rectangular base measures 10 m. by 5 m. The upper floor, which will be devoted to the observations, is covered with a flat roof, toward which ascent is made by a spiral staircase leading from the basement upward through the whole building, and above the flat roof to a small platform destined for meteorological observations.

The whole observatory has double walls to protect the observers against the cold. The windows and doors are also double, and provided on the outside with shutters closing hermetically. The floor is made of double planks, and furnished with trap doors giving access to the snow supporting the observatory, and to the screw jacks placed in position for adjusting the level of the building in case the snow should yield. The building will be provided with heating apparatus and all the furniture necessary to make habitation at such an altitude possible.

Up to the present the observatory has been transported in parts to Chamounix. On the Grands-Mulets a cottage has been erected for the use of the workmen and for storing the things destined for the observatory.

On the Grand Rocher Rouge another cottage has been built, only 300 m. below the summit, in which the workers and observers can, if necessary, take refuge. Three-quarters of the materials for the observatory have been transported to the Grands-Mulets (3,000 m.) and the rest to the Rocher Rouge (4,500 m.)

This year the erection on the summit will be carried out. An astronomical dome, which is to complete the observatory, will also be taken in hand. The work done up to now has been carried out under great difficulties, owing to the fact that everything had to be carried by hand. But no accident has so far marred the success.

Dr. Capus, who accompanied M. Bonvalot in his well known expedition to the Pamir, has promised his assistance for certain observations. But the observatory will be international, and open to all observers who wish to work there. E. E. F. d'A.

*Janssen, *Comptes Rendus*; *Nature*.

A LARGE METEORITE FROM AUSTRALIA.

IN the *Mineralogical Magazine and Journal of the Mineralogical Society* of July, 1887 (vol. vii.) Mr. L. Fletcher, M.A., F.R.S., president of the society, describes four specimens of a new meteoric iron found at Youndegin, in Western Australia. They were discovered about three-quarters of a mile to the northwest from the top of Penkarring Rock, in the above district, about seventy miles from York. These fragments were found by Alfred Eaton, a mounted police constable, when on duty in the district of Youndegin, when he brought in one of the four pieces he found on January 5, 1884. Mr. Fletcher states that the late Mr. Edward T. Hardman, F.G.S., the then government geologist, expressed his belief in the meteoric origin of these iron masses. Later the above named Alfred Eaton was sent with a native assistant with instructions to bring in the other three pieces, and at the same time an unsuccessful search was made for additional fragments. In the above account it is stated that the four pieces were lying loose on the surface, three of them close together, and the fourth fifteen feet away. They weighed respectively 25¾ lb., 24 lb., 17½ lb. and 6 lb. The largest and smallest fragments are now in the British Museum collection, and the specimen of 24 lb. is in the Geological Museum at Freemantle, and the fourth piece, weighing 17½ lb., was presented to the Melbourne Museum in Victoria.

The new specimen now in my possession was discovered in 1891, and weighs 382½ lb., and measures 22¾ inches high, 20⅛ inches wide, and 13¼ inches in its greatest thickness. In form it is roughly convex on one side and concave on the other, on both sides of which are large depressions or pittings similar to those usually observed on other large masses of meteoric iron. It is somewhat triangular in outline, but with irregular sides. It has one small hole quite through the mass near the top, and numerous deep holes, one near the bottom left-hand corner having a diameter of about 1½ inches and 4 inches deep; another at the opposite bottom corner 2 inches deep and 2 inches in diameter; also another of 3 inches deep, and several others. On the upper edge especially, and at several other parts near, also on the edges, are fractured surfaces, as if in its fall a mass or masses were broken off, leaving a coarse crystalline structure, and which would indicate that several other large holes having existed before its fall on the earth, probably all or most of the pieces were connected together, and might have fallen in one mass. It would be interesting to know if any of the pieces fitted together at the fractured surfaces, as seems to me might be possible. I observe that the two specimens of this iron in the British Museum collection exhibit similiar fractures on the edges. Before receiving this specimen I was informed that two masses were found, but have no information at present as to the size and weight of the other.

Mr. Fletcher in his paper minutely describes the size and form of the two British Museum specimens, and that the specific quantity was determined from three small pieces from the larger specimen, and gave 7·86, 7·85, and 7·72. He also states that a portion was cut off the larger piece by means of hack saws, and was found to be so hard that three weeks were required to detach a fragment of which the cut face was not 2½ inches square.

Mr. Fletcher also states that on treating a specimen of this Youndegin iron to the action of bromine water, or of dilute nitric acid, the polished section gave no definite figures, but assumed a damascened appearance very like the Tucuman iron and of that of Brazos, being very similar to the latter in the proportion and distribution of the Schreibersite; some specimens of the Arva, the Sarepta, and the recently found Canon Diablo are similar as exhibiting these characters.

The Youndegin iron was also remarkable in containing the minute cubic and modified cubic crystals, having metallic luster and of a grayish black color, and which were determined to be graphitic in character, but of a diamond-like form; but were later found to be still distinct from the diamond, but having somewhat more the features of graphite. Mr. Fletcher therefore decided to give the name of Cliftonite to this substance, as being a new form of a carbon mineral. A most exhaustive description of this new mineral is given in his paper. Similar crystals of this substance are found in one or two other meteoric irons.

The composition of the Youndegin iron was found to be as follows:

Iron	92·67
Nickel	6·46
Cobalt	0·55
Copper	trace
Magnesium	0·42
Phosphorus	0·24
Sulphur	none
Insoluble cubes	0·04
	100·38

—*James R. Gregory, in Nature.*

FLORAL UTILIZATION OF TREE STUMPS.

FROM time immemorial horticulturists have secured the double advantage of setting off their plants and also producing shade effects in winter gardens by raising to certain distances from the ground broad leaved subjects (such as Ferns, Palms, and Cycads) the stems of which were too short for the desired elevations.

The device—a pleasing one enough in its way—which we employed up to the last few years, and which consisted in surrounding the prop and the plant box or tub with a metal grating and filling up the intervening space with a compost in which could be grown Selaginellas, Tradescantias, Oplismenus, Fittonias, etc., to cover and conceal the grating, is, however, open to the objection that both the plant tub and its wooden support are very liable to decay in consequence of their constantly moist surroundings, and also that the soil in the plant tub, becoming channeled by frequent waterings, is apt after some time to be more or less pervaded with cavities, the effect of which is very detrimental to the well being of the plant.

Taking into consideration the durable qualities of cork, which have been proved by the satisfactory use that has been made of it in this respect for some time past by Orchid growers, Professor Gerard, director of the Botanic Gardens at Lyons, and myself thought that this material might answer well for making artificial tree stumps, the exterior of which, being formed of a substance which naturally covers the trunks of certain trees, would have a natural appearance—a feature in which all the existing arrangements of this kind were entirely deficient.

For this purpose the proper kind of cork should be selected, rejecting the handsome smooth slabs from which bottle corks are cut and which are technically known as "female" cork, as this kind does not possess the furrowed exterior which the artist who wishes to imitate Nature should seek for. The proper kind to use is technically named "male" cork, and is that which is first produced on the tree. The outside of this being much more furrowed and uneven than that of the other kind, it is commonly rejected by cork cutters, for the very same reason which renders it preferable for our present purpose. Cork of this kind can be procured from Spain, or, doubtless, more easily and cheaply from Algeria, from which country we have imported without any great difficulty more than 22 cwt. of "male" cork during the last three years, at a cost of twenty-five francs (£1 sterling) per 220 lb., delivered at Marseilles. It is sent to us in broad, flat slabs and also in cylindrical rolls, the former of which are used in making the body of the stump and the latter for the branch stumps and pockets. After being immersed in hot water for a quarter of an hour the slabs of cork become as pliable as leather, and can be moulded to any form the gardener wishes. In this work, however, he should always be assisted by an artist competent to suggest some pleasing and effective design. The cork, when it cools, retains the form to which it has been moulded, and it is fastened on with a few small nails.

It is probable that by adding to the hot water a few crystals of sulphate of copper the cork would be rendered still more durable, and, taking into account the high character which this chemical bears as a preservative agent, we intend to try it, hoping that it will not injuriously affect the pliability of the cork nor be in any way detrimental to the plants.

The second stage: The trunk of the tree covered with male cork.

We give three illustrations here which, better than any long description, will indicate both the different stages of construction and the effect which "male" cork exhibits when used for this purpose. The first figure shows the skeleton of the structure—a piece of a tree trunk firmly fixed in the ground and supporting a broad tub, in which will be planted some such subject as a Latania borbonica (Livistona chinensis, R. B.), as shown in the second figure, in which both stump and tub are entirely concealed by the covering of cork which has been attached, in the first place, to the tub and then to a number of rafters which have been disposed so as to give a sufficient width to the lower part of the structure. The third illustration shows the completed artificial tree stump furnished and embellished with various epiphytal plants, fine-leaved Begonias, Ferns, Aroids, Pepper-worts, Bromeliads, etc. The varieties of plants and the modes in which they may be arranged in these ornamental structures are without number. Of course, Orchids will form some of the most elegant and effective subjects. Mosses, Selaginellas and Grasses, such as Oplismenus imbecillis and its variegated variety, may also be employed to great advantage. Lastly, I would specially recommend that some of the fine graceful twiners should be allowed to grow pendent from the extremities of the branch stumps. Climbing plants are everywhere to be met with in warm and temperate glasshouses, and the only difficulty is in making a selection where the number of eligible subjects is so large.

The first stage: The trunk of a tree and a tub.

As concerns the structure itself, it will at least be acknowledged that the transformation is of such a kind that its artificial character is not perceptible—the very result that was aimed at!—*E. Devillat, in Revue Horticole; The Garden.*

THE FLORIDA PITCHER PLANT.

By CHARLES B. PALMER, A.M.

AMONG the many curious and interesting objects that came under my notice during a residence of several years in Florida, none interested me more than an insectivorous plant (*Saracenia variolaris*). It bears a single radical flower, the most striking feature of which is the style, which expands into a broad umbrella, entirely inclosing the flower. But it is not of the flower, but of the pitcher-like leaf which I wish to speak.

When the young leaf first makes its appearance it is spatulate in form, with a simple notch on one side near the end, ranging upward at an angle of about 45 degrees. As the plant grows the sides separate, forming a tube, while the notch increases in size and rotates in direction, until it becomes an ample opening ranging downward at an angle of about 45 degrees. At the same time the end of the spatula enlarges into a dome-shaped hood, the upper lip at the opening projecting well forward and downward over the lower. The tube is largest at the top, narrowing gradually to a point a short distance above the ground. The front or open side of the tube has a narrow rib, the rest of the circumference being round and smooth.

If one were to say that he had seen a tree which could catch and eat squirrels, rabbits, field mice, etc., he would be set down as a bungling imitator of the celebrated baron; but here is a frail plant which we tread upon unnoticed, that actually captures, devours and digests numbers of animals endowed with much greater activity, and doubtless with higher powers of perception, than any mammals. If the plant has any odor attractive to insects it is not perceptible to human olfactories. But when near the opening they seem possessed with a desire to enter, and the way is open and easy. At the edge of the opening they are seen to sip a secretion of the plant and immediately hasten on to the interior. Here some of them will continue to eat ravenously until they are seized with a sort of palsy, causing them to tremble violently, lose their hold and fall into the liquid at the bottom of the tube. Others, after entering the dome, become frightened and endeavor to escape. And here is discovered one of the remarkable features of the plant—an arrangement clearly intended to deceive the unlucky prisoner. The hood projecting over the opening forms a dark background, while the opposite side of the dome is brilliantly lighted by means of more than a hundred transparent spots or windows. Just as a bird which has entered a room by a dark passage beats against the window pane, so the poor insect exhausts his strength at the windows of his prison, and finally falls exhausted—literally "in the soup."

The bath seems to cure their palsy, for they invariably struggle vigorously to escape by climbing up the side of the tube. But the effort is vain. It seems remarkable that insects which walk upon glass and other smooth surfaces at will can make no progress here. The inner surface of the tube has a wonderfully smooth feel, and under the microscope is seen to be covered with very fine hairs, forming a nap in the downward direction. About half-way up the tube there is a change in the appearance. It looks as if the lower part were wet and the upper dry, but the microscope shows that the appearance is caused by a different arrangement of the hairs on the surface. On the upper half they appear like bundles of grain with the ends well spread. The purpose of this arrangement is not apparent; but having on one occasion found a larva at the half-way point, it occurred to me that possibly certain species had feet able to traverse the lower half, and such would be stopped by the different arrangement above. However this may be, the insect which once enters this doubly and trebly guarded prison "leaves hope behind." Even when rescued he seems unable to resist the temptation to taste again the insidious nectar which leads him to his doom. Cut away the hood and let a blade of grass down into the tube. A half-dead fly climbs eagerly out. Too weak to fly, he can be handled at will. Place him on the outside of the tube, an inch or more from the opening, with head turned away from danger. He staggers forward a few steps, then stops and considers, then like the confirmed toper in front of a saloon, turns around and goes back for one more drink. At the first taste he becomes crazed, and sips ravenously till the tremens comes on and drops him down to certain death.

The number and variety of insects disposed of by a single plant is astonishing. Every order is represented. One would think that a grasshopper large enough to reach across the tube and almost close it up with his body and long legs would have small excuse for being in such a place. But there he is slowly dissolving. Beetles, moths, larvæ of numerous kinds, including large woolly caterpillers, all go the same way. The hymenoptera are represented by ants, but I have never found any species of bee, though I have searched diligently for that special purpose.

The statements of certain botanists that the pitchers are "half filled with water containing drowned insects," and that "it is difficult to believe that they have any connection with the economy of the plant," need revising. A chemical analysis of the fluid is wanting, but it is a secretion of the plant and not rain water. The construction of the plant makes it impossible for rain to enter. Furthermore, I have seen a plant which had been cut off at the root send up a new leaf, mature its pitcher, secrete its fluid and begin business, during a period in which no rain had fallen.

In every healthy pitcher may be found insects still alive and struggling; others dead; others farther down in the mass, coarsely broken up, and at the bottom only a pulp. The fact that the elytra, mandibles and other hard parts of beetles are dissolved with the rest, shows that the plant has remarkable digestive powers. Unlike animals, it has no means of rejecting unsuitable portions of food. Everything goes. The front door is always open; there is no back door; all sorts of visitors enter, none escape; every shred disappears.—*Science.*

TOBACCO AND WINE BACTERIA.

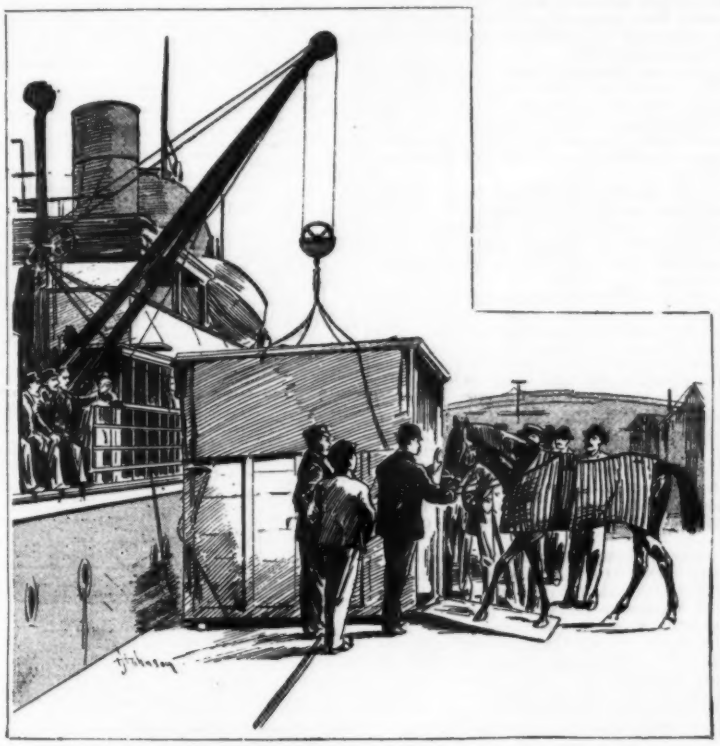
THE fermentative changes which the leaves of the tobacco plant are made to undergo before they are worked up and finally handed over to the public are of the greatest importance in determining the quality of any particular tobacco. It was formerly supposed that the alteration in its condition thus brought about was due to purely chemical changes induced by the process of "sweating" which the leaf undergoes, but some interesting experiments made recently go to show that these important results are effected by special micro-organisms. In a paper read before the German Botanical Society, Suchsland gives an account of some investigations which he has been conducting on the bacteria found in different kinds of tobacco. He has examined fermented tobacco from all parts of the world, and found large numbers of micro-organisms, although but few varieties, mostly only two or three different species in any particular brand and but rarely micrococcus forms. But what is of especial interest is the discovery that pure cultures of bacteria obtained from one kind of tobacco and inoculated on to another kind, generated in the latter a taste and aroma recalling the taste and aroma of the tobacco from which the pure cultures had been in the first instance procured. Thus it may be possible in the future to raise the quality of German tobacco, not, as heretofore, so much by careful culture and judicious selection of varieties, which has so far proved unsuccessful, but by inoculating pure cultures of bacteria found in some of the fine foreign tobaccos on to our own raw material, whereby similar fermentative changes may be induced and the quality correspondingly improved. The further results promised by Suchsland will be looked for with much interest. In connection with the above experiments on the "transplantation," so to speak, of micro-organisms, it is interesting to note some results obtained lately by Nathan (*Die Bedeutung der Hefenreinzucht fur die Obstweinbereitung*). The amount of alcohol present in such wines as cider, currant wine, etc., is generally from 3 to 4 per cent. This small pro-

The final effect: The trunk of the tree covered with plants.

portion is possibly in part due to the necessarily large dilution of the fruit with water, which considerably reduces the nitrogenous constituents of the "must," and also to the fact that the yeast, according to Hansen, mostly present on sweet fruits is the *Saccharomyces apiculatus*, which only possesses a feeble fermentative power. Experiments were made to see whether, by increasing the nitrogenous constituents of the "must," and introducing a pure cultivation of a vigorous wine yeast, the yield of alcohol would be greater. It was found that by adding a small amount of nitrogenous material, such as 0·15 grm. ammonium chloride, and 5 cubic centimeters of wine yeast per liter to the "apple must" (which was the fruit selected) 2 per cent. more alcohol was obtained, and not only was this the case, but this cider possessed a finer and more vinous taste than that untreated, or which had only received an additional supply of ammonium chloride without the wine yeast. Kosutany in a paper published in the *Landw. Versuchsstationen*, 1892, has recorded the results of his investigations on the behavior of certain species of wine yeast. He states that not only is the percentage of alcohol yielded very different with particular yeasts, but that also the taste, smell, and bouquet of the wine inoculated with special cultures were distinctly different according to the variety of yeast employed. It is hoped that, as in the case of tobacco so with wine, it may be possible to raise the quality by the judicious transplanting of bacteria obtained from finer brands.—*Nature.*

ORMONDE, THE "HORSE OF THE CENTURY."

ORMONDE—the "horse of the century" as his many admirers have styled him—left the port of Ensenada, La Plata, on December 21, by the steamship Clyde. Our sketch is from a photograph taken at the moment of embarkation, after Ormonde had walked down from



ORMONDE, THE HORSE OF THE CENTURY.

La Plata, a distance of four miles. The Clyde arrived at Southampton on January 12, when the famous horse was found to have stood the voyage remarkably well, and was in first class condition. A brief summary of his racing career will indicate the sources of his exceptional popularity, which must be great indeed when so huge a purchase price as £30,000 has been paid to Senor Bocau, of the Argentine Republic, by Mr. McDonogh, of San Francisco. Ormonde, whose sire is the famous Bend Or, won the Two Thousand Guineas, the Derby, and the St. Leger in one year (1886), a feat which only three horses had previously performed, namely, West Australian in 1853, Gladiateur in 1865, and Lord Lyon in 1866. He won as a two year old £3,008, including the Dewhurst Plate of £1,602; as a three year old, £21,552, including the three classic races above named; and, as a four year old, £3,905 10s., including the Hardwicke Stakes of £2,395 10s. Thus the total winnings in three years of this remarkable and never defeated quadruped amounted to £28,465 10s. In 1889 the Duke of Westminster sold him to Don Juan Bocau for £12,000, who in turn parted with him to Mr. McDonogh for $150,000 last November. —*Daily Graphic.*

HISTORY'S MISLEADING CHRONOLOGY.

By SAMUEL W. BALCH.

THE superintendents of public instruction in the United States, through their executive committee on the Columbus day celebration, have established a new precedent by choosing for America's most impressive anniversary a date nine days later in the season than that on which it has hitherto been taught to belong.

Last February, the administrators of our public schools intrusted to a committee of representative educators from Massachusetts, Rhode Island, Tennessee, and Michigan the duty of preparing public school exercises befitting the anniversary of the discovery of a hemisphere. Foremost among the public acts of this committee was the advising Congress to pass a resolution appointing October 21 as the proper day on which to celebrate the discovery of America. This was done in June last, and in the following month President Harrison issued a proclamation in accordance therewith. Thus October 12, which had become established in the literature of four centuries, and has been inculcated in the minds of generation upon generation, has been suddenly replaced, in the interest of scholarly accuracy, by a date hitherto untaught. Thus public attention is called to a want of accord between the majority of dates recorded in history and the precise seasons of the year which experience has taught us that these dates indicate.

The calendar which is now used by all civilized countries, except Russia and Greece, has an average length of year which corresponds with great precision with the round of the seasons. It does not, however, equal the period in which the earth makes the circuit of the sun and the same stars again return to the same watches of the night. Because of the inclination of the earth's axis and its slow gyration, there is a nodding to and from the sun, alternately, of the northern and southern hemispheres. The interval between successive nods is twenty minutes less than the time in which the earth goes around the sun. As the alternations of summer and winter and the periodic returns of seed time and harvest are due to this nodding movement, its period has been taken as the year, and our modern calendar has very properly been brought as closely as possible into agreement with it, instead of into agreement with the time in which the earth makes its revolution around the sun.

When the change was made from old to new style, two points of departure from the old calendar were ordered. First, ten days were struck out from October, 1752, when Pope Gregory XIII. ordered that the change should be made, and second, he ordered that three years in four centuries, which under the old rules would be leap years, should henceforth be common years. This second point of departure was all that was really necessary to keep the calendar to its place in the future. The first was ordered so as to bring the vernal equinox back to the day of the month on which it was observed by the members of the Council of Nice. Now it is a matter of fact, which has not before been noticed, that one day too many was omitted to correct the calendar back to the century in which the council met; for, when our modern calendar is extended backward, it will approach the old style calendar one day each time a year divisible by 100 and not by 400 is passed. This rate leaves the calendars still one day apart in the year 325, when the council met, and it is not until the preceding century, when the members of that council were boys, that the two coincide. That the world might for all time be able to mark the equinoxes and the lengthening and shortening of the days opposite the same dates in their diaries as did the members of that council in their boyhood, the ten days were consequently omitted. The confusion was introduced and chronology was bungled. To carry the correction of the calendar back to the first century of its existence would require the omission of two additional days.

In the year 532, Dionysius Exiguus invented the idea of marking time in the year of our Lord. His speculations as to when that was placed it on the twenty-fifth of March, nine months and a week earlier than the point of time from which we now number. Other chronologists differed with Dionysius as to the point of time from which to reckon, and as a consequence years of the same number were commenced by different provinces at no less than seven different times. The effect of this on history is illustrated in the reign of Charlemagne. His coronation took place on Christmas Day, according to the records, in the year 801 A. D., but as the years were commenced on December 25, history properly dates the coronation in the year 800 and does not consider the year 801 to have commenced until the first of the following January. During his reign the custom of beginning the year at Christmas was changed and the twenty-fifth of the following March substituted. The king died early in the historical year 814, but the record of the time calls the year 813 A. D. Thus, although the difference between the years of record of his coronation and death is but twelve, yet he died in the fourteenth year of his reign.

From the illustrations that have been given, it will be clear that the dates with which many of the events of history were originally recorded do not convey to us a true idea of the time when those events transpired. To do this a uniform system of dating is needed, and two are candidates for the position; namely, the old and the new styles, with the years commencing at the first of January. The histories divide their patronage between them, designating both in the same manner and frequently affording no indication as to which one they are following. The new style already dates all that has transpired during the past century and a half, and is destined to be employed in the history of the future. To discard it is therefore impossible. With Washington's birthday, the landing of the Pilgrims, and the founding of Boston for the only notable exceptions, the old style marks all the history of England and her colonies prior to 1752, and all other history prior to the past three centuries. The old style as it is usually written in the histories, since it begins its years at January 1, is not the old style that was actually used, but a corruption of it. We have therefore a historical literature using a chronology that, in its dates prior to revision of the calendar, neither presents them uniformly as they were written at the time nor as they are now generally understood.

Dates in the old style calendar are usually accompanied by the letters A. D. or B. C. We now know that these abbreviations are not true statements concerning the years to which they are applied. It will therefore be proper to discard them and make their absence the distinguishing feature of the new chronology, while in books already written we may appropriately interpret the former abbreviations to mean, According to Dionysius, and the latter as, Bad Chronology.

Two systems of notation are followed in numbering the years before Christ. They differ from each other by a year, and may be designated as the historical and the astronomical systems of notation. The first, on the supposition that the year 1 was Christ's year, calls the year preceding, 1 B. C. This would be technically correct if the original supposition were true, yet, granting the supposition, it is objectionable for two reasons. First the leap years will fall in odd numbered years instead of in years divisible by four, as at present. Thus since the year 4 was a leap year, the leap year preceding would be assigned to 1 B. C., the next to 5 B. C., and so on. Second, the interval between dates will not be equal to the sum of the numbers of the years. Thus we cannot find the space of time between 2 B. C. and 1 A.D. by adding 2 and 1 together, as the result will be too great by one year. Likewise the interval from 2 B. C. to 2 A. D. is three, instead of four years. The astronomical system overcomes the above objections by introducing a year zero between the years 1 before and 1 after, as in longitude a zero meridian intervenes between the meridians one degree east and one degree west. In this system the proper method for distinguishing the years will be with the minus sign, since it will indicate that the years are available for calculation along with plus years according to the rules of algebra.

That all the dates of ancient events should be given according to our modern calendar is probably both impracticable and undesirable Especial significance attaches to many dates because of their connection with time-honored holidays, and for this reason they should be preserved. It is, however, desirable that we should know the relation between the dates of each century of history which are recorded in the old style and our present calendar for anniversary purposes. To this end it seems that all works on history should make prominent mention, in connection with each period treated, of the relation between the calendar then used and the calendar of the present day.

The following table has been prepared to show what this relation is for each century since the commencement of the Christian era. It gives the first and last date of each period during which the difference is constant. Up to the twelfth century the Roman notation was generally used; and since this added the extra day in leap year by doubling the sixth before the calends of March, corresponding to February 24, the change is properly indicated on that day of the month instead of on February 29, up to that time.

TABLE FOR ASCERTAINING TRUE ANNIVERSARIES OF OLD STYLE DATES.

Julian Day.	Week Day.	New Style Date.	Year from Jan. 1, New Style	Difference	Old Style Date.	Year from Jan. 1, Old Style.
1,721,424	Sat.	Dec. 30	0*	—2	Jan. 1	A. D. 1
1,721,426	Mon.	Jan. 1	1	—2	" 3	1
1,757,637	Mon.	Feb. 22	100	—2	Feb. 24	100*
1,757,638	Tue.	" 23	100	—1	" 24	100*
1,794,162	Sun.	" 23	200	—1	" 24	200*
1,794,163	Mon.	" 24	200	0	" 24	200*
1,830,687	Sat.	" 24	300	0	" 24	300*
1,830,688	Sun.	" 25	300	1	" 24	300*
1,903,737	Thu.	" 25	500	1	" 24	500*
1,903,738	Fri.	" 26	500	2	" 24	500*
1,940,262	Wed.	" 26	600	2	" 24	600*
1,940,263	Thu.	" 27	600	3	" 24	600*
1,976,787	Tue.	" 27	700	3	" 24	700*
1,976,788	Wed.	" 28	700	4	" 24	700*
2,049,787	Sun.	" 28	900	4	" 24	900*
2,049,888	Mon.	Mar. 1	900	5	" 24	900*
2,086,362	Sat.	" 1	1,000	5	" 24	1,000*
2,086,363	Sun.	" 2	1,000	6	" 24	1,000*
2,122,887	Fri.	" 2	1,100	6	" 24	1,100*
2,122,888	Sat.	" 3	1,100	7	" 24	1,100*
2,195,941	Sun.	" 7	1,300	7	" 28	1,300*
2,195,942	Mon.	" 8	1,300	8	" 29	1,300*
2,232,466	Sat.	" 8	1,400	8	" 28	1,400*
2,232,467	Sun.	" 9	1,400	9	" 29	1,400*
2,268,991	Fri.	" 9	1,500	9	" 28	1,500*
2,268,992	Sat.	" 10	1,500	10	" 29	1,500*
2,342,041	Wed.	" 10	1,700	10	" 28	1,700*
2,342,042	Thu.	" 11	1,700	11	" 29	1,700*
2,378,566	Tue.	" 11	1,800	11	" 28	1,700*
2,378,567	Wed.	" 12	1,800	12	" 29	1,800*
2,415,091	Mon.	" 12	1,900	12	" 28	1,900*
2,415,092	Tue.	" 13	1,900	13	" 29	1,900*

Astronomers make their calculations in days, and for this purpose number them in a system based on the Julian year. These are given in the first column of the table. Leap years in either system are designated in the table by the sign (*).

The table is extended down to the next century, but, of course, the differences cease to apply to the chronology of each country now using our modern calendar since the date of its adoption. These are given in Bond's "Art of Verifying Dates," as follows:

Rome, Milan, greater part of Italy, Spain, and Portugal, October 15, 1582.

France, December 20, 1582.

German Roman Catholic states, Prussia, Roman Catholic Netherlands, Holland, and Zeeland, January 1, 1583.

German Protestant states and Protestant Netherlands, March 1, 1700.

Sweden, gradually, by omitting leap years from 1696 to 1744.

Great Britain and Ireland, September 14, 1752.—*Education.*

EXPANSION OF AIR BY HEAT.

THE expansibility or distension of solids, fluids, and gases by heat is a very extensive physical law, although generally unobserved, and is of the greatest importance in chemistry. Examples of the expansion of air by heat are very numerous. The following are some of the more simple processes of this kind, which I have found will illustrate this law as plainly as possible.

A small stoppered bottle of two or three cubic inches capacity is to be filled with pure air (at a low temperature), which may be practically done by the application of the lips to the mouth of the bottle, so that one-half only of it is covered (the other part remaining open), and the air drawn out by suction; its volume is then replaced by external air drawn in through the remaining aperture to supply its place. This being done, the stopper can be wetted and loosely replaced. The bottle should now be tightly held in the warm hand, and the stopper will then be seen to pop up two or three times, emitting a jet of expanded air each time. If under the same circumstances the stopper, instead of being loosely replaced, is a little tightened, it will completely jump out by the application of the heat as above. Now if oxygen or hydrogen gas (both which are very combustible) is substituted for common air, the same experiment repeated, an ignited match held over the stopper, each jet of gas will produce a small blue flame.

FIG. 1.—A glass bulb immersed in hot water with a piece of wet membrane over its mouth, blown out by the dilation of the contained air.

A second simple method is to take a thin glass bottle, loosely tie a thin piece of caoutchouc or wetted membrane over the mouth, and then immerse it in water

FIG. 2.—A glass vessel after being immersed in boiling water. The air has been reduced to less than half its volume, as shown by the contained fluid.

at the temperature of ebullition (100° C.) The membrane will bulge out, and ultimately burst if it be very thin (Fig. 1). On the other hand, if the same bottle is immersed in cold instead of hot water, contraction of the inclosed air will consequently result, and the membrane will be drawn in more or less deeply concave. Not only does this law apply to gases (which are most sensible to it), but also in a less degree to fluids, and less still to solid bodies as above remarked.

Another good way of illustrating the same law, and perhaps the most obvious of all the preceding, is to obtain a thin glass vessel, with a double communication, that is to say with two mouths. By suction the air is drawn through this vessel by the widest opening, which is then well corked, and the whole immediately placed under boiling water. From the small unstopped aperture numerous small bubbles of air will issue in rapid succession, due to the heat causing the contained air to dilate. When, after the bottle has been immersed a minute or two, the body is held out of water, considerable contraction of the expanded air will ensue, and consequently an equivalent quantity of water will be drawn in; if after remaining thus a short time the vessel is taken out (still inverted) of the fluid, further condensation of the air will result, and small bubbles will continue to be drawn through the water, until the bottle and its contents have attained a temperature alike to that of the surrounding atmosphere (Fig. 2). The water drawn in and the remaining air will be nearly approximate to the air it first contained.

Upon this law is based the construction of the "air thermometer," and thermometers generally.—*Henry E. Griset in Hardwicke's Science-Gossip.*

THERE seems to be no doubt that the natural gas in the Pittsburg field is becoming exhausted, and that its use in manufactories will have to be permanently discontinued. But it will leave behind it a desire for gaseous fuel that will have to be supplied artificially. Several large works outside of the natural gas regions have been compelled to make gas for use as fuel in order to compete with Pittsburg, and now their Pittsburg brethren may be compelled to follow their example.—*Philadelphia Ledger.*

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